The Determinants and The Effects of Provider Continuity on Quality of Care, Clinical Outcomes and Healthcare Costs in Adult Diabetes Patients of Taiwan

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Abstract

Background

Diabetes is a complicated chronic disease. It might cause multiple complications and then result in poor quality of life and premature deaths. Diabetes is also a costly disease. In Taiwan, 11.5% of annual national health expenditures are spent for diabetes care. However, diabetes is an ambulatory care sensitive condition. With appropriate treatment in primary care setting, diabetes could be controlled and its complications could be prevented. Continuity is an essential component of primary care. Improving continuity in primary care is thought to improve quality of care and outcomes in diabetes patients.

Objectives and Research Questions

The objectives of the study are to examine the determinants of provider continuity for adult diabetes patients in Taiwan; and to explore the effects of provider continuity on quality of care, clinical outcomes and healthcare costs among adult diabetes patients in Taiwan. This study will answer four major research questions. Are the patient, provider and organization characteristics associated with different degree of provider continuity among diabetes patients in Taiwan? Do diabetes patients with high provider continuity get better quality of care? Do diabetes patients with high provider continuity get better clinical outcomes? Do diabetes patients with high provider

continuity have reduced diabetes-related healthcare costs?

Materials and Methods

We used claims data from Longitudinal Health Insurance Database 2005 (LHID2005), Taiwan to conduct the study. Adults diagnosed as diabetes patients and had diabetes-related outpatient visits for at least four times per year during 2004 to 2008 were enrolled for analysis. UPC (usual provider continuity) was measured as the index of continuity of care. UPC≧0.75 was defined as high continuity. The patient, provider, and organization characteristics were included for analysis. Initially, descriptive statistics were performed to present the demographic data of study population and the time trends of indices of quality of care, clinical outcomes and healthcare costs. Then, a bi-variate analysis with Chi-square test or Student's t-test was done. Finally, generalized estimating equations (GEEs) models with link function of logistic or linear regression were used to analyze the multiple-year data.

Results

There were 16,596 diabetes patients included for analysis. Diabetes patients aged ≧65 years, female, with medium or high income level, cared for by the provider≧45 years, cared for by an endocrinologist or an other subspecialist, usually visiting a private non-profit health organization and usually visiting a health organization governed by Central Division of NHIA had higher odds of high provider continuity

relative to comparisons after controlling for other influences. Patients living in sub-urban areas, with medium or high disease complexity, with more diabetes-related visits, cared for by a female provider, usually visiting a medical center, a regional hospital, or a district hospital, usually visiting the organization governed by Kao-Ping Division or Eastern Division of NHIA had lower odds of high provider continuity relative to comparisons after controlling for other influences. High continuity patients had higher odds of receiving HbA1C test at least twice per year, but had lower odds of receiving annual lipid-profile test, renal function test, and urine protein test according to the recommendations of diabetes guidelines compared with low continuity patients. The odds of receiving annual eye exam were similar between high and low continuity patients. High continuity patients had lower odds of diabetes-related emergency visit(s), and diabetes-related hospitalization(s) compared with low continuity patients. For diabetes patients usually cared for at local clinics, high continuity patients spent less money on outpatient (OPD) medication costs, total OPD costs and total healthcare costs. But for patients usually cared for at medical centers, regional hospitals, or district hospitals, we found high continuity patients spent more money on diabetes-related OPD medication costs; total outpatient costs; and total healthcare costs compared with low continuity patients, despite the negative association between high continuity and diabetes-related healthcare costs at local clinic level.

Conclusion

With the study, we found the factors affecting provider continuity, diabetes-related quality of care, clinical outcomes and healthcare costs. Although high provider continuity didn't improve the diabetes patients' behaviors to receive diabetes-specific tests or exams, but it did significantly reduce diabetes-related emergency visit(s) and hospitalization(s). Improving provider continuity should be beneficial for diabetes patients. We should understand the causes resulting in low continuity and try to modify the behaviors of the patients and the providers to improve provider continuity. In addition to provider continuity, our study also found the accreditation level of the healthcare organization influenced healthcare costs greatly. These findings could help healthcare policy makers to think about how to develop policies to reduce healthcare costs in the future.

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Chapter 1: Introduction

1.1 Background

Diabetes is one of the most common chronic diseases in the world. The incidence and prevalence of diabetes is increasing continuously over time because of life style change. It has become a global healthcare issue in the last decades. The International Diabetes Federation (IDF) estimated that 382 million people had diabetes worldwide in 2013, and this is expected to increase to 592 million by 2035 (Guariguata et al., 2014). The World Health Organization (WHO) had reported that the global prevalence of diabetes in adults aged 18 years and older reached to an estimated 9% in 2014 (Geneva, 2014b). Diabetes is a complicated chronic disease. With the long duration of getting diabetes, people might suffer from multiple complications, such as retinopathy, neuropathy, nephropathy, and vascular diseases. The complications of diabetes could lead to poor quality of life and even premature deaths. There were 1.5 million people directly died of diabetes in 2012 (Geneva, June 2014). Mathers and Loncar projected that, diabetes will be the seventh leading cause of death worldwide by 2030 (Mathers & Loncar, 2006). Diabetes is a costly disease. In the United States, the total estimated cost of diagnosed diabetes was $245 billion USD in 2012, including $176 billion in direct medical costs and $69 billion in reduced productivity. It was 41% increased

compared with the previous estimate of $174 billion in 2007 (American Diabetes Association, 2013). The IDF estimated that the global health expenditure on diabetes was at least $548.5 billion USD in 2013 (Beagley, Guariguata, Weil, & Motala, 2014). Therefore, diabetes is associated with huge physical and economic burdens..

Diabetes is also a prevalent chronic disease in Taiwan. Recent studies using National Health Insurance (NHI) claims data indicated that the prevalence of diabetes in people aged 20 years and older ranged from 4% and 8% in Taiwan, and the prevalence had increased over time (Jiang, Chang, Tai, Chen, & Chuang, 2012; C. C. Lin et al., 2013). In recent years, diabetes has been the fourth or fifth leading cause of death in Taiwan (Ministry of Health and Welfare, Taiwan, April 2105). Lin et al. found that the direct healthcare costs for diabetes patients accounted for 11.5% of total healthcare expenditures in 1997/1998 in Taiwan (T. Lin, Chou, Lai, Tsai, & Tai, 2001). However, diabetes is an ambulatory care sensitive condition (ACSC). With appropriate treatment in primary care setting, diabetes could be controlled and its complications could be avoided. Accessibility, continuity, comprehensiveness, coordination and accountability are five essential attributes of primary care. Improving continuity in primary care is thought to improve quality of care and outcomes in diabetic patients.

There are a lot of studies that examined the effect of continuity of care on patient

satisfaction, quality of care and health outcomes since 1970s. Initially, the studies targeted children and pediatric services (Becker, Drachman, & Kirscht, 1972; Becker, Drachman, & Kirscht, 1974; Heagarty, Robertson, Kosa, & Alpert, 1970; Roos, Roos, Gilbert, & Nicol, 1980). Since 1990s, a quantity of studies observed Medicaid or Medicare patients (Christakis, Wright, Koepsell, Emerson, & Connell, 1999; Gill, 1997; Gill & Mainous, 1998; Gill, Mainous, & Nsereko, 2000; Mainous & Gill, 1998; Weiss & Blustein, 1996). Most studies of continuity of care had focused on general conditions rather than on specific diseases, such as diabetes. The previous studies that explored the association between continuity of care and outcomes in diabetes patients were essentially conducted in local settings, such as local communities, specific cities, provinces or states. Usually, the studies have had small sample size and short study periods (Gill, Mainous, Diamond, & Lenhard, 2003; Gulliford, Naithani, & Morgan, 2007; Parchman & Burge, 2002; Parchman, Pugh, Noel, & Larme, 2002). There were relatively few studies done nationwide. What is more, the results of those studies were inconsistent.

Most studies that examined the relationship between continuity of care and outcomes have controlled for patient characteristics, but few have considered the characteristics of the provider or the organization. According to a framework developed by Aday and Anderson for evaluating access to medical care, health service

utilization is affected by both the characteristics of population at risk and the characteristics of the healthcare delivery system (Aday & Andersen, 1974; Aday et al., 1999). Continuity of care could be an indicator for evaluating access to medical care. To completely investigate the effects of continuity of care, we should take the factors associated with the patient, the provider and the organization into account together.

The previous studies investigating the factors associated with continuity of care were usually performed with questionnaires or surveys. Although questionnaires or surveys are helpful for identifying the perceptions of the study population, they may not reveal actual health-seeking behaviors. With claims data, we would more easily understand the people's actual behaviors. Therefore, this study analyzed detailed claims data collected by the national healthcare system in Taiwan to elucidate the health-seeking behaviors of adult diabetes patients. All the characteristics of the patient, the provider and the organization would be included for analysis.

1.2 Healthcare System in Taiwan

The healthcare system in Taiwan is well known as universal health insurance coverage and unrestricted physician choice. The government of Taiwan has launched a National Health Insurance (NHI) program since 1995. The NHI program in Taiwan is compulsory for citizens who has established residency for six months and more, or infants born in Taiwan with a household registry. As of 2014, the NHI system covered

99.9% of Taiwan's population, and 93% of the healthcare organizations in Taiwan were contracted with NHI. Taiwan's NHI system is a social insurance system that guarantees equal access to healthcare services. People living in Taiwan can go everywhere to seek the medical care what they want. Either general practitioners or specialists working at clinics or hospitals provide primary care to patients. To encourage people to visit community clinics first but not hospitals for primary care, National Health Insurance Administration (NHIA) implements a four-level co-payment scheme. People pay different amount of co-payment when they visit different level of health organizations. People pay $50NTD ($1.56USD) for each outpatient service provided at local clinics, $80NTD ($2.5USD) for each outpatient service provided at district hospitals, $240NTD ($7.5USD) for each outpatient service provided at regional hospitals, and $360NTD ($11.25USD) for each outpatient service provided at medical centers. Since the co-payment is not expensive, lots of people prefer visiting specialists working at hospitals directly to family physicians or general practitioners first. The freedom of physician choice might influence care continuity, quality, clinical outcomes and healthcare costs. A study showed endocrinologists provided better quality of care to diabetes patients than internists or generalists in Taiwan (W. Lin, Chang, & Yaung, 2003), but there are no studies focused on the differences in clinical outcomes and healthcare costs among different specialty care.

From this study, we could further understand the influence of unrestricted physician choice on care continuity, quality, clinical outcomes and healthcare costs.

So far, the evidences are difficult to comment on the impact of continuity of care for diabetes patients, especially within a universal health care system without restriction on physician choice. It is also doubtful if specialty care would be better than generalist care for diabetes patients, especially in terms of clinical outcomes and healthcare costs. Further studies to explore the effect of continuity of care in diabetes patients and examine the diversities between specialty care and generalist care are necessary.

To further understand the trends of health-seeking behaviors of patients and get more information, this study performed a longitudinal analysis with a multiple-year data to strengthen the inference of our study.

1.3 Study aims:

This study had the following objectives:

A. To examine the determinants of provider continuity for adult diabetes patients in Taiwan.

B. To examine the effects of provider continuity on quality of care among adult diabetes patients in Taiwan.

C. To examine the effects of provider continuity on clinical outcomes among adult diabetes patients in Taiwan.

D. To examine the effects of provider continuity on healthcare costs among adult diabetes patients in Taiwan.

1.4 Significance:

This study used national claims data to explore the factors contributed to continuity of care in diabetes patients; and to understand how provider continuity influenced quality of care, clinical outcomes and healthcare costs. The target population was adult diabetes patients, who are the population with extensive health needs and spend large proportion of health care expenditures. This is a national study with large sample size and long study time period. The results would help policy makers to develop efficient strategies to enhance continuity in primary care settings and then to improve the overall quality of care delivered to adult diabetes patients in Taiwan.

Chapter2. Literature Review

2.1 The Epidemiology and Burdens of Diabetes:

With life style change and increased life longevity, the prevalence of Diabetes is increasing dramatically with time. A systematic review conducted by Danaei et al. estimated that there were 152 million people worldwide with diabetes in 1980, and the number increased to 347 million in 2008. The global aged-standardized adult diabetes prevalence was estimated to be 8.3% in men and 7.5 % in women in 1980, and it rose to 9.8% in men and 9.2% in women in 2008 (Danaei et al., 2011). The International Diabetes Federation (IDF) estimated that there were 366 million people worldwide with diabetes in 2011, and the number is expected to rise to 552 million by 2030 (Whiting, Guariguata, Weil, & Shaw, 2011). The report of WHO showed the global prevalence of diabetes among people aged 18 years and older in 2014 was estimated to be 9% (Geneva, 2014a). Diabetes will result in multiple complications and then cause death. According to the estimate of WHO, 1.5 million deaths were directly caused by diabetes in 2012 (Geneva, June 2014). WHO projected that diabetes will be the 7th leading cause of death in 2030 (Mathers & Loncar, 2006). Diabetes is also a costly disease. The global health expenditure on diabetes was estimated to be at least 376 billion USD in 2010 and 490 billion USD in 2030. Globally, 12% of the health

expenditures (around 1330 USD per person) were spent on diabetes in 2010 (Zhang et al., 2010).

The prevalence of diabetes in Taiwan is high and variant depending on different study methods. An epidemiological study conducted by Chang and his colleagues showed the prevalence of diabetes in Taiwan was between 4.9% and 9.2% during 1985 to 1996 and the prevalence of diabetes rose significantly with age for both genders (Chang et al., 2000). Chou et al. reviewed the previous studies investigating the epidemiology of type 2 diabetes in Taiwan and concluded that the age-adjusted prevalence of previously diagnosed diabetes ranged from 2.2% to 6.9%. The prevalence of newly diagnosed diabetes was around 4.0%. And the annual incidence rate was about 1.8% (Chou, Li, & Tsai, 2001). A national survey conducted to detect the prevalence of hypertension/hyperglycemia/hyperlipidemia in 2007 showed the age-standardized prevalence of hyperglycemia (identified as people with fasting blood glucose level≥ 126 mg/dL or take hypoglycemic medication) for people aged 20 years and older was 8.0% (Male: 8.8%, Female: 7.4%). The prevalence was increased with age for both genders and was negatively associated with socioeconomic status (Health Promotion Administration, Ministry of Helath and Welfare, Dec.18th 2012). A study using National Health Insurance (NHI) claims data to survey the prevalence of type 2 diabetes for people aged 20 years and older showed the crude annual

prevalence of type 2 diabetes was 5.79% in 2000 and it increased significantly to 8.30% in 2007 (C. C. Lin et al., 2013). Jiang et al. found the population of diabetes in Taiwan increased greatly during 2000 to 2009. There were 0.71 million people with diabetes in 2000 and the number rose to 1.22 million in 2009. With a near constant standardized incidence rate (0.78%~0.86%), there was a more than 70% increase in the total diabetes population in Taiwan during 2000 to 2009. The age-standardized prevalence rate was 3.15% in 2000 and up to 4.22% in 2008. The increase of standardized prevalence rate was around 35% (Jiang et al., 2012).

Over time, diabetes will damage the blood vessels, kidneys, eyes and nerves. The study of Huang et al. found the prevalence of diabetic nephropathy in Taiwan was 13.32% in 2000 and increased to 15.42% in 2009. The corresponding diabetes dialysis rate was 1.50% in 2000 and increased significantly to 2.46% in 2009. The prevalence rate of diabetic retinopathy increased from 6.17% in 2000 and 8.91% in 2009. The prevalence of peripheral vascular disease also increased from 1.87% to 2.47% during the same period (Y. Huang et al., 2012). In Taiwan, diabetes was the 12th leading cause of death in 1981, the 7th leading cause of death in 1986, and became the 5th or 4th leading cause of death since 1991. The standardized mortality rate attributed to diabetes was around 40 per 100,000 population in 2001, decreased to 35 per 100,000 population in 2006 and, 2007, and continuously decreased to 25 to 27 per 100,000

population during 2008 to 2013. It is much higher compared with other countries in Asia and Pacific area (e.g. Japan, Singapore, Australia and Korea) or other developed countries (e.g. USA, UK and Germany) (Ministry of Health and Welfare, Taiwan, April 2105; Ministry of Health and Welfare, Taiwan, April 2105). The international comparison of standardized mortality for diabetes is showed in Appendix 1.

The national claims data revealed that there were roughly 600,000 people seeking medical care for diabetes in 2003 in Taiwan. Each diabetes patient had about 10 OPD visits and 0.07 hospitalizations averagely. 1,600 NTD (50 USD) was spent per OPD visit and 43,300 NTD (1,353USD) per hospitalization. The direct health care costs for diabetes were around 12 billion NTD (375 million USD) (National Health Insurance Administration, Taiwan, Oct. 2012). It accounted for 3% of annual national health expenditures.

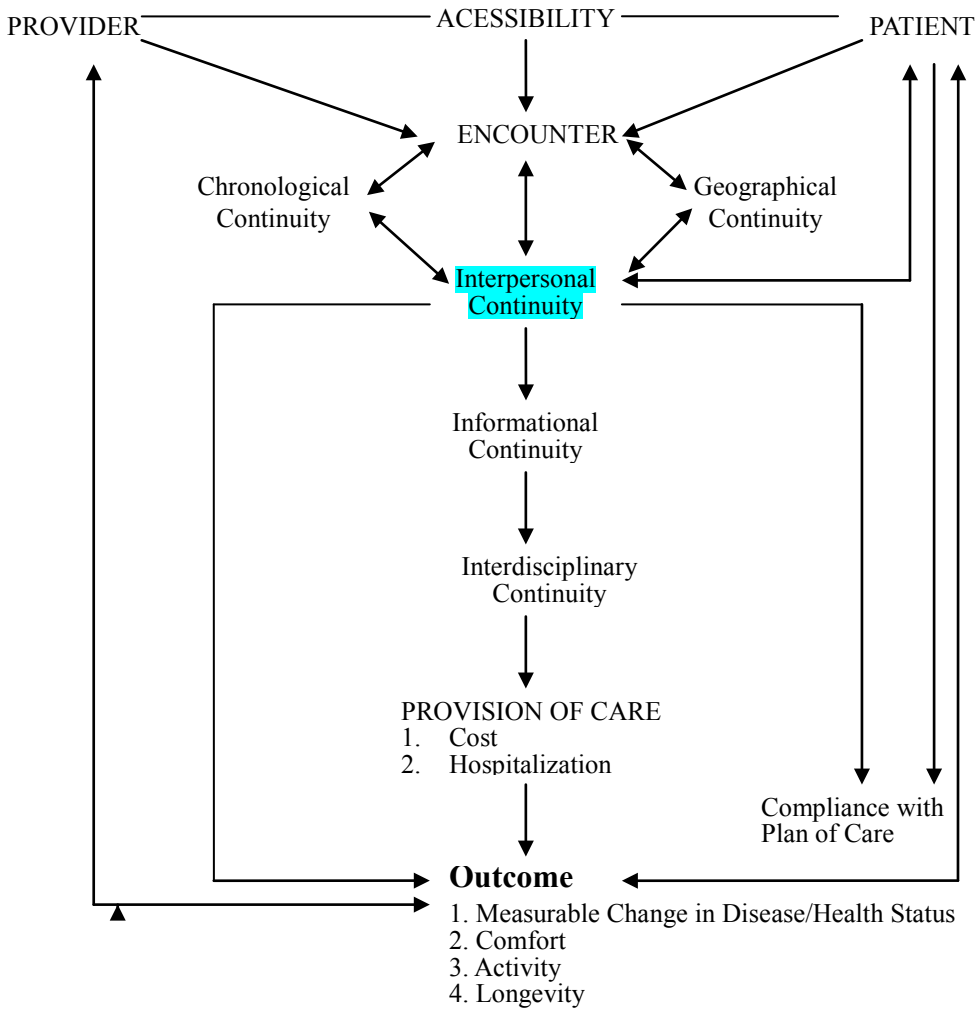
Due to the big physical and economic burdens caused by diabetes, developing policies to improve quality of care for diabetes patients, and then to improve clinical outcomes and reduce health expenditures has become a very important health care issue in Taiwan.

2.2 Continuity of Care and the Measurement

Primary care, defined as 'the provision of integrated, accessible health care services by clinicians who are accountable for addressing a large majority of personal health care needs, developing a sustained partnership with patients, and practicing in the context of family and community" (Institute of Medicine, 1994), is an key element to maintain an effective and efficient health care system (Green, Phillips, & Fryer, 2005). Accessibility, comprehensiveness, coordination, continuity, and accountability are five essential attributes of primary care (Institute of Medicine, 1978). There are interrelationships among all of the attributes. For example, continuity, which is achieved depending on accessibility and accountability, could be the apparent means to reach comprehensiveness and coordination. Continuity of care is a broad concept. It is not an entity but an attitude operated through actions (Hennen, 1975; Wall, 1981). Hennen classified the act of providing continuity of care to four dimensions: chronological, geographical, interdisciplinary, and interpersonal continuity (Hennen, 1975). Rogers and Curtis added informational, accessibility and stability dimensions to extend the continuity model (Rogers & Curtis, 1980). Wall extracted five of these, including chronological, geographical, interdisciplinary, interpersonal, and informational continuity, to build a framework exploring the relationship between continuity process and outcomes *(Figure 2.1)* (Wall, 1981). Because it is a very big

scope to examine all the continuity dimensions at one time, researchers usually focus on one or two dimensions to investigate the impact of continuity on outcomes. Interpersonal continuity is one dimension of continuity of care studied commonly.

Figure 2.1: The continuity process and relationship to outcome



(Adopted from: Continuity of Care and Family Medicine) (Wall,E.M. 1981)

The interpersonal dimension of continuity includes doctor-patient relationships, doctor-family relationships, interpersonal family relationships, and interprofessional relationships (Hennen, 1975; Rogers & Curtis, 1980). The doctor-patient relationship (provider continuity) is discussed the most frequently. Depending on different study purpose and available data source, several indices to measure provider continuity in ambulatory care had been developed, i.e. Usual Provider Continuity (UPC), Continuity of Care (COC), LICON, SECON, GINI, CON, and LISECON. The first four measures (UPC, COC, LICON, and SECON) are individual-based measures and can be compared directly. The later three measures (GINI, CON, and LISECON) are population-based measures and it is difficult to compare one measure with the others (Steinwachs, 1979). UPC and COC are the most commonly used indices (Christakis, Mell, Koepsell, Zimmerman, & Connell, 2001; Gill, 1997; Gill et al., 2003; Kearley, Freeman, & Heath, 2001; Knight, Dowden, Worrall, Gadag, & Murphy, 2009; W. Lin, Huang, Wang, Yang, & Yaung, 2010; V. H. Menec, Sirski, & Attawar, 2005; V. H. Menec, Sirski, Attawar, & Katz, 2006; Parchman & Burge, 2002; Roos et al., 1980). UPC developed by Breslau and Reeb is a simpler measure. It reflects the fraction of the total visits to the usual provider (Breslau & Reeb, 1975). UPC reveals the concept of having a regular or usual source of care, but it is not sensitive to changes in the number of different providers whom a patient visits during the study period. COC

developed by Bice and Boxerman is a measure of dispersion (Bice & Boxerman, 1977). It takes both the total number of visits and different providers into account and "is sensitive to changes in the number of visits and their distribution across different providers" (Steinwachs, 1979). Modified Continuity Index (MCI) and Modified Modified Continuity Index (MMCI) were developed later and try to overcome the deficiencies of UPC and COC (Godkin & Rice, 1984; Magill & Senf, 1987). MCI and MMCI are also used frequently to evaluate continuity of care (Gill & Mainous, 1998; Gill et al., 2003; Maciejewski et al., 2013; Parchman et al., 2002). Some studies use Number of Providers (NOP) to measure provider continuity (De Maeseneer, De Prins, Gosset, & Heyerick, 2003; Raddish, Horn, & Sharkey, 1999). Some studies use patients' self-report to detect whether they have a usual provider or not (Raivio, Holmberg-Marttila, & Mattila, 2014). Experienced Continuity of Care (ECC) developed by Gulliford et al. is a new tool to measure continuity with questionnaire (Gulliford, Naithani, & Morgan, 2006).

The type of data source also determines the measures of continuity. Different measures of continuity will be chosen depending on different available data source, e.g. chart/medical record, claims data or surveys (Jee & Cabana, 2006).

2.3 The Determinants of Provider Continuity

To improve continuity of care, it is necessary to understand the determinants of continuity first. There are a few studies investigating factors affecting provider continuity. Most studies focused on the relationship between provider continuity and patient characteristics (e.g. age, sex, health status, number of visits, and length of registration). Provider characteristics (e.g. specialty, board certification or not, years of current practice, accessibility, age, and sex) and organization characteristics (e.g. practice size, clinical frequency, and patient load) were also examined in some studies.

2.3.1 Patient Characteristics:

Many researchers like to apply questionnaires or surveys to explore the patients' or providers' views of continuity of care. A questionnaire interview with patients and general practitioners (GPs) conducted at Oxford, UK showed patients with increasing age, more frequent consultations, longer registration with the practice, and easier access to the chosen physician were more likely to receive care from a personal GP. But, there was no significant relationship between receiving care from GP and patient's sex, socioeconomic factors or convenience (Kearley et al., 2001). A survey conducted in the Netherlands found patient characteristics, such as age, sex, marital status, living area, and frequency of visits to the GP, not significantly affected the

patients' views on continuity of care (Schers et al., 2002). A survey conducted in U.S.A. showed extremes of age (≦12 years or ≧40 years), female, less educational level, number of visits, number of chronic illnesses, number of medications taken and worse self-reported health status were associated with higher value placed on continuity (Nutting, Goodwin, Flocke, Zyzanski, & Stange, 2003). A 15-year follow-up questionnaire survey conducted in Finland found that patient-reported continuity of care had declined by 15% (from 66% to 51%) over the past 15 years (1998~2013). The quantitative analysis showed aged ≧60 years, non-urgent visit, visit in preceding 12 months, and appointed doctor were linked to high continuity, but female patients were linked to low continuity (Raivio et al., 2014).

30 years ago, (Goldberg & Dietrich, 1985)(Goldberg & Dietrich, 1985)Goldberg et al. had used medical chart data to study the continuity of care provided to primary care patients by different type of physicians. They found patient characteristics (i.e. age, sex, and years with primary physician) were not predictive of the level of continuity (Goldberg & Dietrich, 1985). Cornelius used data from the 1987 National Medical Expenditure Survey to study the degree of continuity of care among Americans with different ethnicity. They found Latino Americans were more likely to have a high continuity with their regular physician than Whites. For all Americans, older people and those who were in fair or poor health status, and lived in rural areas

had a lower degree of continuity of care. There was no difference between low continuity and high continuity groups in terms of patient sex, income level and months at source (Cornelius, 1997). However, Overland et al. found older Australian diabetes patients were more likely to attend one doctor other than multiple doctors. Similar to the study of Cornelius, Overland et al. also found there was no significant difference between two groups in terms of patient sex and length of time under the care of the referring doctor. The duration of diabetes, and the proportion of patients with the micro- or macro-vascular complications related with diabetes were also not different between the two groups in the study (Overland, Yue, & Mira, 2001). A study conducted in Manitoba, Canada found rural people were more likely to see the same doctor compared with urban people (V. Menec, Black, Roos, & Bogdanovic, 2001). The study of Maeseneer et al. conducted in Belgium found that patients who were female, had financial difficulties, lived in urban areas, reported more than 1 chronic disease and had poorer health and functional status were more likely to visit different FP(s) (i.e. without continuity). But there was no difference in terms of patient age and educational level (De Maeseneer et al., 2003). Another study of Menec et al. observing older adults living in Manitoba showed there was no significant difference between high continuity and low continuity groups in terms of patient age, sex, marital status, educational level and self-reported health status. But the patients who

had moved had a poorer continuity profile compared with those who had not moved. They also found that people with low continuity profile had more total number of visits to all physicians compared with high continuity group (V. H. Menec et al., 2006). Knight et al. studied elderly people with diabetes in Newfoundland and Labrador (NL), Canada showed patients in high-continuity group were less likely to be female, but the association was significant only with COC index. They also found patients in high-continuity group was younger and had less additional chronic conditions compared with those who in low-continuity group, but there was no significant difference between high- and low-continuity groups in terms of income level (Knight et al., 2009). A study conducted in an urban underserved community found older diabetes patients had higher median MMCI score compared with younger diabetes patients. But there was no significant difference in the median MMCI by gender and ethnicity (Younge, Jani, Rosenthal, & Lin, 2012).

2.3.2 Provider Characteristics:

The study of (Goldberg & Dietrich, 1985)(Goldberg & Dietrich, 1985)Goldberg et al. examining the continuity of care provided to primary care patients by different type of physicians found UPC score was not different during family physicians, general internists and medical subspecialists. Physician characteristics, such as age, board certification or not, or years of current practice, were not predictive of the level

of continuity (Goldberg & Dietrich, 1985). The study of Cornelius found sex, specialty and ethnicity of the regular physician were associated with the degree of continuity of care. Americans whose regular physician was female, a specialist, an African or Latino American were more likely to have low usual provider continuity (Cornelius, 1997). A questionnaire survey conducted in 3 different health care system (i.e. England and Wales, the United States, and the Netherlands) to examine the physicians' perception of continuity of care showed female GPs had positive attitude toward personal continuity of care in England; younger GPs had positive attitude toward personal continuity of care in the United States; and full-time GPs had positive attitude toward personal continuity of care (Stokes et al., 2005). Mittelstaedt et al. used mixed-methods to examine the relationship between provider practice characteristics and interpersonal continuity. The quantitative analysis found duration in practice and provider type (i.e. physician vs. mid-level provider) were positive predictors of continuity; but there was no significant difference in UPC by provider sex. The qualitative data from provider focus group interviews suggested that providers with more years in practice might have more mature relationships with their patients, and then could achieve the benefits of continuity. However, different from the result of quantitative analysis, the focus group interviews mentioned that female and male providers may have differences in scope of practice and approach to care.

Patients could be concerned for maternity leave of female providers and then result in lower continuity in female providers (Mittelstaedt, Mori, Lambert, & Saultz, 2013).

2.3.3 Organization Characteristics:

The effect of organization/practice characteristics on continuity of care was seldom examined in previous studies. With the change of practice pattern in recent decade, there is increasing interest in this field. Practice type and setting might influence continuity of care. Maciejewski et al. examined the continuity and quality of care for patients with access to different health care systems. They found the mean continuity of primary care varied in different health care system users. MMCI was highest for Medicare fee-for-service (FFS) users, next highest for Veteran Affairs (VA) users, and lowest for dual users (Maciejewski et al., 2013). The study of Mittelstaedt et al. showed clinical frequency was a positive predictor of continuity, but patient load was a negative predictor (Mittelstaedt et al., 2013). A study conducted in Ontario, Canada showed significant negative association was found between group size and continuity. Organizations with more physicians experienced declines in continuity (Devlin et al., 2013).

2.4 Provider Continuity and Quality of Care, Outcomes and Costs

There are many studies investigating the association between interpersonal

continuity of care and care outcomes. Saultz and Lochner systematically reviewed studies done between 1966 and 2002. They found the most common care outcomes examined were delivery of preventive services (e.g. immunizations, pap tests, breast exams or mammogram), hospitalization rate, quality of doctor-patient relationship, indicators of chronic illness management, and maternity care outcomes. The most common cost variables examined were costs related with hospitalizations, emergency department (ED) visits, OPD visits, appointment no-shows, medication prescriptions, and utilization of diagnostic tests(Saultz & Lochner, 2005).

2.4.1 Provider Continuity vs. Hospitalizations, Emergency Visits

A randomized trial conducted by Wasson et al. to investigate the effects of provider continuity in elderly men showed patients in the continuity group had fewer emergent admissions and a shorter average length of stay compared with patients in the discontinuity group (Wasson et al., 1984). However, Gill examined the effects of continuity in Delaware Medicaid patients during 1992 to 1993 and found that patients with a regular source of care (RSOC) were not less likely to be hospitalized for all conditions or ACSCs compared with patients without an RSOC (Gill, 1997). Different results were noted with different methodology and study period. Gill analyzed the claims data of Delaware Medicaid population during 1993 to 1994 and found high provider continuity was associated with less ED use (Gill et al., 2000). Gill's study

using claims data during 1993 to 1995 found high provider continuity was associated with a lower likelihood of hospitalization for all conditions and chronic ACSCs, but not for acute ACSCs (Gill & Mainous, 1998). The study of Weiss and Blustein examining the impact of duration of tie to usual source of care on the process and costs of medical care showed older Americans had long-standing ties with their physicians and the long-standing physician-patient relationship ties were associated with a decreased likelihood of hospitalization and lower costs (Weiss & Blustein, 1996). Cabana and Jee systematically reviewed the articles published during 1966 to 2002 and concluded that sustained continuity of care (SCOC) could improve quality of care by decreasing hospitalizations, decreasing ED use and improving receipt of preventive services, especially for patients with chronic conditions such as asthma and diabetes (Cabana & Jee, 2004). The similar findings were noted in other studies conducted in a universally insured health care system. Menec et al. found higher continuity with a family physician (FP) was related to better preventive services (including cervical cancer screening, breast cancer screening, influenza vaccination, and pneumococcal vaccination), and reduced ED visits (V. H. Menec et al., 2005). Another study done by Menec showed high continuity of care with a FP was associated with reduced hospitalizations for ACSCs among older adults, but not related with hospitalizations for all conditions (V. H. Menec et al., 2006). A

population-based study conducted in Quebec found elderly people with low or medium level of continuity of care with a primary physician were more likely to visit emergency department compared with those with high level of continuity of care (Ionescu-Ittu et al., 2007).

In recent years, there are several studies conducted in Taiwan to examine the effects of continuity of care on hospitalizations and emergency visits. Studies using Taiwan National Health Insurance Research Dataset to examine the relationship between continuity of care and hospitalizations or emergency visits showed patients with higher continuity of care had fewer hospitalizations (S. H. Cheng, Chen, & Hou, 2010; S. H. Cheng, Hou, & Chen, 2011; Y. C. Huang, Chih, & Cheng, 2010; W. Lin et al., 2010) and fewer emergency visits (S. H. Cheng et al., 2011; Y. C. Huang et al., 2010).

2.4.2 Provider Continuity vs. Costs

The study of (Cornelius, 1997)(Cornelius, 1997)Cornelius using data from the 1987 National Medical Expenditure Survey to examine the degree of usual provider continuity for different ethnic Americans found people with low continuity of care (i.e. UPC≦0.5) reported higher total health costs (Cornelius, 1997). Raddish et al. studied the cost-effectiveness of continuity of care for patients with arthritis, asthma, epigastric pain/peptic ulcer, hypertension or otitis media, and found that health care utilization and costs were increased when a patient visited more primary or specialty

care providers (Raddish et al., 1999). Maeseneer et al. compared two cohorts with or without provider continuity with a FP and found that patients who visited the same FP had a lower total costs for medical care (De Maeseneer et al., 2003). A recent study conducted in Canada showed higher attachment to the practice (i.e. higher continuity) was associated with lower costs, especially for high- and very-high-care-needs patients with chronic conditions (e.g. diabetes, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), hypertension, angina, chronic kidney disease (CKD), osteoarthritis and stroke) (Hollander & Kadlec, 2015).

2.4.3 Provider Continuity vs. Quality of Care in Diabetes Patients

Previous researches to explore the effect of continuity conducted before 2000 relatively less focused on specific diseases. Since the prevalence of diabetes is increasing dramatically in recent decades and the costs for diabetes care are also rising sharply, there are more and more studies investigating the impact of continuity of care in diabetes patients recently. Diabetes is a complicated chronic disease. Patients with diabetes need regular follow-up and ongoing treatment to slow the progression of disease and prevent the development of complications. Continuity of care should be beneficial to diabetes patients.

Traditionally, we assess quality of care by three domains: structure, process, and outcomes. Researchers usually used process indicators and outcome indicators to

examine the effects of continuity of care on quality of care in diabetes patients. The process indicators of diabetes care generally look at if diabetes patients receive specified laboratory tests (e.g. glycosated hemoglobin (HbA1C) test, lipid profile test, and microalbumin test) and exams (e.g. blood pressure (BP) checks, eye exam, and foot exam) according to the recommendations of guidelines. The most commonly used outcome indicators to assess quality of diabetes acre include the percentage of diabetes patients achieving the defined treatment goals in terms of HbA1C level, LDL level, or BP value; hospitalization rate; emergency visits; diabetes-related costs; quality of life indices; and patient satisfaction .

O'Connor et al. found that adult diabetes patients with a regular health care provider were more likely to follow a special diet, monitor glucose levels at home regularly, receive more HbA1C tests, receive more foot exams, and have recommended cholesterol checks. Compared with those without a regular provider, diabetes patients with a regular provider also had more probability to receive insulin therapy, influenza immunization within 1 year, and dilated retinal exams; but the differences were small. There were no significant differences between both groups for dental checkups or endocrinology referral. Diabetes patients with a regular provider also got better glycemic control (O'Connor et al., 1998). Parchman et al. used quality of care score developed by American Diabetes Association Provider Recognition

Program to assess the impact of continuity on quality of care in type 2 diabetes and found that diabetes patients who had visited their usual provider in the past year were more likely to have an eye exam, a foot exam, two blood pressure checks and a lipid test during the year compared with those who had not visited their usual provider (Parchman & Burge, 2002). Parchman also found that provider continuity was associated with better glucose control among type 2 diabetes patients by changing patients' behavior regarding diet (Parchman et al., 2002). But Gill and his colleagues conducted a study in adults with diabetes enrolled in a national private health plan and found there was no significant association between provider continuity and completing of diabetes monitoring tests (i.e. HbA1C test, lipid profile test, and eye exam) (Gill et al., 2003). The study of Younge et al. also showed that there was no significant difference between different levels of provider continuity and process measures of diabetes care (i.e. HbA1C, LDL and microalbumin test rate); although they found low levels of provider continuity were associated with poor HbA1C control and higher levels of provider continuity were associated with good LDL control (Younge et al., 2012). Maciejewski et al. examined whether quality of diabetes care was associated with continuity of care or veterans' usual source of primary care in unaffiliated health systems and found that VA reliance was a stronger predictor of diabetes quality of care than continuity. Under multinomial logistic regression,

continuity of primary care was not significantly associated with underprovision or overprovision of HbA1C testing, microalbumin testing and eye exams (Maciejewski et al., 2013).

Hanninen et al. had used Short-Fom-20 General Health Survey (SF-20) to assess the impact of continuity of care on health-related quality of life (HRQOL) in Finland people with diabetes. They found good continuity of care was positively associated with the better well-being dimensions of the SF-20 in terms of mental health, health perception, and painlessness. However, there was significantly higher HbA1C level in good continuity group compared with poor continuity group (Hanninen, Takala, & Keinanen-Kiukaanniemi, 2001). Gulliford et al. examined the relevance of experienced continuity of care (ECC) in diabetes patients, and found ECC was associated with greater patient satisfaction, but not associated with improved intermediate outcomes, i.e. HbA1C level, the value of systolic blood pressure, body mass index, and HRQOL (Gulliford et al., 2007).

Booth and Hux found diabetes patients with a regular source of care were less likely to be hospitalized or visit ED for an acute complication of diabetes (Booth & Hux, 2003).The study of Knight et al. showed higher continuity of FP care was significantly associated with reduced hospitalizations in elderly people with diabetes (Knight et al., 2009). A study conducted in Korea revealed diabetes patients with

low continuity of care had higher hospitalization rate compared with high continuity group, and the effect was more significant in the older people. But level of continuity of care was not significantly associated with poor glycemic control (Ki et al., 2014).

There are also some studies conducted in Taiwan to investigate the effects of provider continuity on quality of diabetes care. The study of Lin et al. showed diabetes patients with low to medium continuity of care had increased risk of admissions compared with high continuity group. The effect was significant for admissions related to long-term complications of diabetes, but not short-term complications (W. Lin et al., 2010). Chen et al. found diabetes patients with high or medium provider continuity were less likely to have diabetes-related hospitalizations or ED visits. They also found diabetes patients with high or medium provider continuity had lower annual expense for medications and healthcare overall compared withpatients with low continuity. It meant higher level of continuity of care could reduce healthcare costs (C. C. Chen & Chen, 2011). A recent study of Cheng et al. found level of continuity of care was not associated with the completion of annual HbA1C test, but high continuity of care was significantly associated with reduced diabetes -related hospitalizations, inpatient costs, OPD costs and total healthcare costs (J. S. Cheng et al., 2015).

Chapter3. Research Methodology

3.1 Conceptual Framework

The conceptual framework was developed according to the framework constructed by Aday and Andersen for the study of access to medical care (Aday & Andersen, 1974). The characteristics of population at risk and healthcare delivery system would affect the utilization of healthcare services, and then influence quality of care, clinical outcomes and costs.

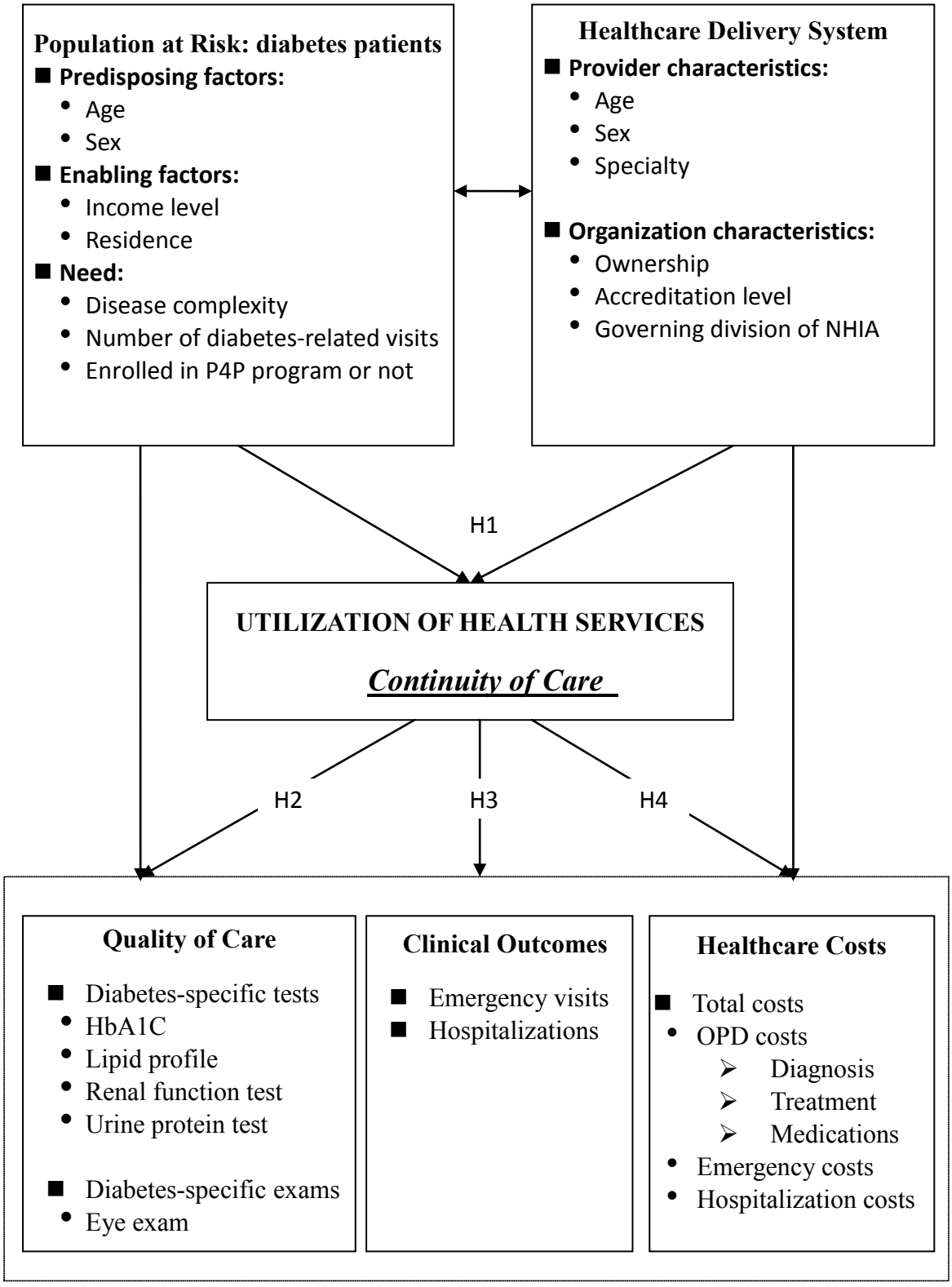
Characteristics of population at risk could be divided to three components: predisposing factors, enabling factors and patients' needs. The predisposing factors exist before the onset of illness episodes. In our study, they include age and sex. The enabling factors are resources or attributes help patients to access healthcare services, including patients' income level and residence. The need component talk about illness level, including disease complexity, number of diabetes-related visits, and enrolled in "pay for performance" (P4P) program or not.

Characteristics of healthcare delivery system include two main elements: resources and organization. In our study, provider characteristics, such as providers' age, sex and specialty, and organization characteristics, including organization type and grade, would be taken into analysis.

For utilization of healthcare services, we used continuity of care as an index to assess the effect. Continuity of care is a measure to examine the long-term relationship between providers/health services and patients/illnesses. People with low continuity could be considered to be short of appropriate access to healthcare services.

To examine the impact of continuity of care on diabetes patients, we used process indicators of quality of diabetes care, diabetes-related emergency visits and hospitalizations, and diabetes-related healthcare costs as outcome measures in the framework. The detail of conceptual framework is listed in Figure 3.1.

Figure 3.1: Conceptual Framework



3.2 Research Questions and Hypotheses

Based on the conceptual framework, we would like to answer the following research questions and test the hypotheses.

RQ1: Are the patient, provider and organization characteristics associated with different degree of provider continuity among diabetes patients in Taiwan?

H1: Patient, provider and organization characteristics are associated with different degree of provider continuity.

H1.1: Different characteristics of patients affect degree of provider continuity.

H1.1a: Older patients have higher provider continuity than younger patients.

H1.1b: Female patients have higher provider continuity than male patients.

H1.1c: Patients with high income level have higher provider continuity than those with low income level.

H1.1d: Patients living in suburban areas of Taiwan have higher provider continuity than those who live in urban areas of Taiwan.

H1.1e: Patients living in rural areas of Taiwan have lower provider continuity than those who live in urban areas of Taiwan.

H1.1f: Patients with more diabetes-related complications/comorbidities have lower provider continuity than those without diabetes-related complications/comorbidities.

H1.1g: Patients enrolled in P4P program have higher provider continuity than those

who are not enrolled in P4P program.

H1.1h: Patients with more annual diabetes-related outpatient visits have lower provider continuity than those with less annual diabetes-related outpatient visits.

H1.2: Different characteristics of providers affect degree of provider continuity.

H1.2a: Patients have higher provider continuity if their usual providers are older.

H1.2b: Patients have lower provider continuity if their usual providers are female.

H1.2c: Patients have higher provider continuity if their usual providers are endocrinologists or other subspecialists.

H1.3: Different characteristics of organizations affect degree of provider continuity.

H1.3a: Patients who usually visit public organizations have lower provider continuity.

H1.3b: Patients who usually visit local clinics have higher provider continuity.

RQ2: Do diabetes patients with high provider continuity get better quality of care?

H2: Diabetes patients with high provider continuity are more likely to receive diabetes-special tests and exams according to the recommendation of guidelines.

H2.1: Diabetes patients with high provider continuity are more likely to receive $\geqq 2$ HbA1C tests annually.

H2.2: Diabetes patients with high provider continuity are more likely to receive annual lipid profile test.

H2.2: Diabetes patients with high provider continuity are more likely to receive annual renal function test.

H2.2: Diabetes patients with high provider continuity are more likely to receive annual urine protein test.

H2.2: Diabetes patients with higher provider continuity are more likely to receive annual eye exam.

RQ3: Do diabetes patients with high provider continuity get better clinical outcomes?

H3: Diabetes patients with higher provider continuity have less diabetes-related emergency visits and hospitalizations

H3.1: Diabetes patients with higher provider continuity have less diabetes-related emergency visits.

H3.2: Diabetes patients with higher provider continuity have less diabetes-related hospitalizations.

RQ4: Do diabetes patients with high provider continuity have reduced diabetes -related healthcare costs?

H4: Diabetes patients with high provider continuity have reduced OPD medication costs, total OPD costs and total healthcare costs.

H4.1: Diabetes patients with high provider continuity have reduced OPD medication

costs.

H4.2: Diabetes patients with high provider continuity have reduced total OPD costs.

H4.3: Diabetes patients with high provider continuity have reduced total healthcare costs.

3.3 Study Design:

The study is a population-based observational longitudinal cohort study. To save time and money, people were used to conduct a study with a cross-sectional analysis. However, a cross-sectional design can only provide information at one given point in time; it can't show the information of the trend of patients' health-seeking behaviors. Compared with a cross-sectional study design, a longitudinal design will demonstrates the changes in continuity of care over time. Besides, longitudinal data analysis would account for variation among individuals and unobserved time-invariant characteristics of patients (Twisk, 2013). Therefore, we choose the longitudinal analysis with a multiple-year data to strengthen the inference of our study.

3.4 Data Sources

We used claims data from National Health Insurance Database (NHIRD), Taiwan to conduct the study.

The government of Taiwan has launched a National Health Insurance (NHI) program since 1995. NHI is a mandatory, single-payer social health insurance system. As of 2014, 99.9% of Taiwan's population was enrolled in NHI, and 93% of health care organizations were contracted with NHI (National Health Insurance Administration, 2015). All contracted health care organizations need to fill out the claims data monthly to the National Health Insurance Administration (NHIA, previously known as the Bureau of National Health Insurance (BNHI)) to get reimbursement. Every year, NHIA collects the claims data to construct the National Health Insurance Research Database (NHIRD). The NHIRD includes registration files and original claims data. The registration files provide information of health care organizations, providers, and beneficiaries. The original claims data provide detailed information of utilization and costs in OPD care, hospitalizations and prescriptions. Longitudinal Health Insurance Database 2005 (LHID2005) is a sub-dataset of NHIRD. LHID2005 contains all the original NHI claims data of 1,000,000 beneficiaries who were randomly sampled from the year 2005 Registry for Beneficiaries (ID) of NHIRD. There were approximately 25.68 million individuals in year 2005 registry file. The

sampling rate is approximately 3.9%. There is no significant difference in the age distribution, gender distribution or average insured payroll-related amount between the people in the LHID2005 and the original NHIRD (NHRI,). We will use LHID2005 to identify the study population and count the outcome variable (i.e. provider continuity), and use registration files of NHIRD to get the information of providers and health care organizations. The data files which will be used in our study are listed in Table 3.1.

Table 3.1: The data files used in the study

Longitudinal Health Insurance Database 2005 (LHID2005)
Ambulatory care expenditures by visits (CD)
Details of ambulatory care orders (OO)
Inpatient expenditures by admissions (DD)
Details of inpatient orders (DO)
Expenditures for prescriptions dispensed at contracted pharmacies (GD)
Details of prescriptions dispensed at contracted pharmacies (GO)
Registration files from NHIRD
Registry for contracted medical facilities (HOSB)
Registry for medical personnel (PER)
Registry for beneficiaries (ID)

3.5 Study Population

The study population consists of adult diabetes patients diagnosed before the end of 2003 and had diabetes-related OPD visits for at least four times per year during 2004 to 2008.

Firstly, we identified patients aged 18 years and older from the year 2003 claims data of LHID2005. Then, diabetic patients were identified if patients met one of the following criteria: (i) a principle diagnosis code of 250.** (ICD-9-CM code) or A181 (ICD-9 A-code) was found in the OPD claims data (CD/OO file), (ii) patients took hypoglycemic medications accompanied with any secondary diagnoses of above codes. To make sure the validity of diabetes diagnosis, only patients with four and more diabetes OPD visits were selected for study population. Lin et al. assessed the validity of Taiwan's health insurance claims data for diabetes diagnosis and found that the overall concordant rate of diabetes diagnosis between Taiwan's NHI claims data and patients' self-reports was 74.6%. The accuracy of diabetes diagnosis was significantly associated with the number of diabetes OPD visits. The concordant rate would reach to 96.1% for patients with four and more diabetes OPD visits (C. C. Lin, Lai, Syu, Chang, & Tseng, 2005).

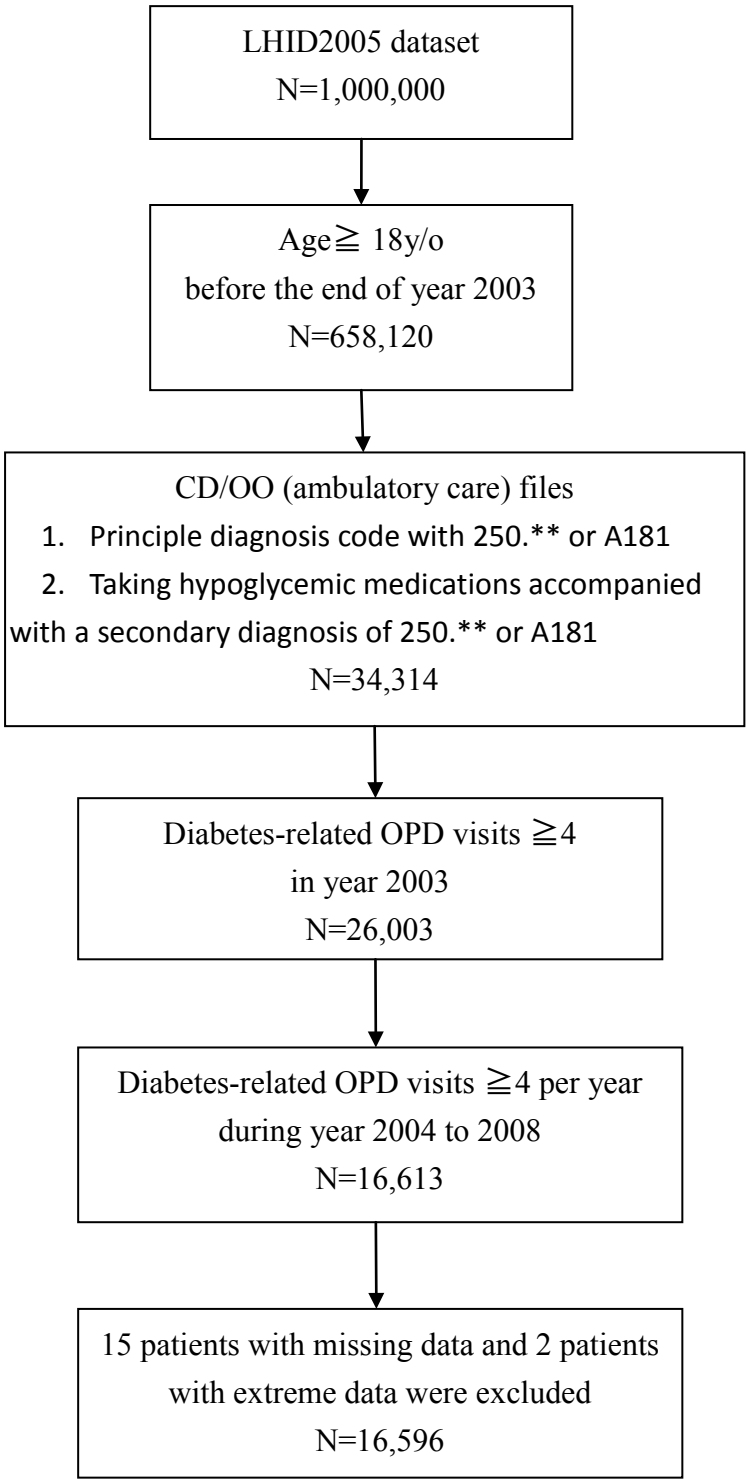
To get a meaningful continuity index, a minimal diabetes OPD visits per year for each patient should be considered. We excluded patients with three or less diabetes-

related OPD visits per year during 2004 to 2008 in the study because a meaningful continuity index could not be generated. Only patients with at least four diabetes-related OPD visits per year were included in the study. There were 16,613 diabetes patients enrolled in our study.

Among the 16,613 diabetes patients included in our study, 15 patients had missing data because either gender or age of their usual provider was unknown. Two patients had extreme data because age of their usual provider is very old (i.e. 93 y/o, 108 y/o). It seemed unreasonable. The missing and extreme data accounted for 1% of total sample size, and we decided to exclude the 17 patients from study population. Finally, 16,596 diabetes patients were enrolled in the analysis.

The flow chart of study population sampling is listed in Figure 3.2.

Figure 3.2: The flow chart of study population sampling



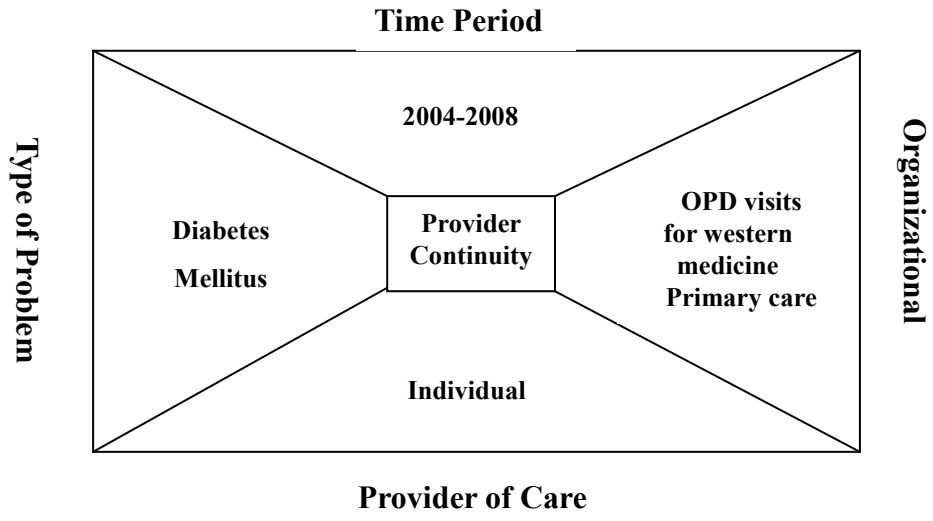
3.6 Definition of Variables and Measurement

3.6.1 Continuity of Care: Usual Provider Continuity (UPC)

There are several indices for provider continuity measurement. Based on available information from our data source, we choose a commonly used and well-validated index--UPC to evaluate provider continuity. Usual Provider Continuity (UPC) is a simple measure of continuity density. UPC is defined as the number of visits to the most frequently visited provider divided by the total number of visits to all providers. The equation for the index is as follows: $UPC = \frac{\mathrm{n1}}{\mathrm{N}}$. N is the total number of visits. n_1 is the number of visits to the usual (the most frequently visited) provider.

To measure provider continuity, we need to specify four basic dimensions: the type of problems or conditions; time period; organizational context; and definition of the provider (Steinwachs, 1979). Figure 3.3 showed the four dimensions of provider continuity in our study.

Figure 3.3: Four dimensions of provider continuity in the study



The definition of provider accounted for provider continuity is any physician who provides essential care to diabetic patients. In Taiwan, patients can go anywhere to seek medical care without referral from primary care physicians. As a result, some specialists and sub-specialists, especially for internal medicine or neurology, also provide essential care for diabetic patients. These physicians, including general practitioners, family physicians, specialists and sub-specialists of internal medicine, and neurologists, will be counted as primary care providers in our study.

Diabetes-related OPD visits to the providers defined as above during year 2004 and 2008 will be extracted for provider continuity calculating. Diabetes-related OPD visit is identified if the claims data with a principle diagnosis code of ICD-9-CM 250.0-250.9 or ICD-9 A-code A181; or with a secondary diagnosis of above codes and hypoglycemic medications or blood sugar tests are prescribed.

Since the study of Jee and Cabana showed that different visit type will affect the measure of continuity of care (Jee & Cabana, 2006), our study calculated continuity index using diabetes-related OPD visits for western medicine care. The OPD visits for traditional Chinese medicine, dental care, emergency care, OPD surgery, home care, nursing home care, preventive services, and special programs for HIV and tuberculosis are excluded.

We can not calculate meaningful provider continuity index if the number of total

visits is small. To get reliable provider continuity index, we restrict our study population to patients with at least 4 diabetes-related OPDs visits per year during the study period for analysis.

Different studies use different cut points to distinguish different degree of continuity. Studies in Canada, where with a universally insured health system similar to Taiwan, identified patients with greater than 75% of all their visits to the same physician as high continuity of care, and those with less than 75% of all their visits to the same physician as low continuity of care (V. Menec et al., 2001; V. H. Menec et al., 2005; V. H. Menec et al., 2006). For easy interpretation, we divided our study population in to two groups: high provider continuity (UPC$\geqq$0.75) and low provider continuity (UPC$<$0.75).

3.6.2 The Patient Characteristics and Needs

Age: The patient's age was measured with his/her age at the beginning of year 2004. We classified the variable to 3 categories: young, middle and old age. Diabetes patients aged 44 years and less were coded as young age group. Diabetes patients aged between 45 and 64 years were coded as middle age group, and those who aged 65 years and older were coded as old age group.

Sex: The patient's sex was categorized to male and female.

Income level: High, medium or low income level was coded according to the

household income presented to NHIA to calculate premiums. In 2005, the minimum wage set by the nation was 15,840 NTD. Low income level was defined as the household monthly income was 15,840 NTD and less. Medium income level was defined as the household monthly income was between 16,500 NTD and 28,800 NTD. High income level was defined as the household monthly income was 30,300 NTD and more.

Residence: We assumed the patients lived near the area where the health organizations which the patients visited the most frequently were located. This variable was coded according to the location of the health organization which each patient usually visited and was classified to 3 categories: urban, suburban, and rural area. The definition of urban, suburban and rural area was referred to the study of Liu (Liu, 2006).

Disease complexity: This variable was measured depending on the complications and comorbidities which a diabetes patient had. Seven different diabetic complications or comorbidities defined by Newton et al. (Newton et al., 1999), including cardiovascular disease, essential hypertension, foot/lower-extremity problems, cerebrovascular disease, peripheral vascular disease, renal disease and eye disease, would be examined with CD file. Diabetes patients without any complication or comorbidity mentioned above were coded as low disease complexity group.

Diabetes patients with only one complication or comorbidity were coded as medium disease complexity group, and those who with two complications/comorbidities and more were coded as high disease complexity group.

Pay-for-performance (P4P) program: The study of Lee et al. revealed enrollment in P4P program would influence the seeking behaviors of diabetes patients (Lee, Cheng, Chen, & Lai, 2010). We assumed enrollment in P4P program could be a confounding factor.

Diabetes-related visits: Total number of diabetes-related ambulatory visits could be associated with the severity of disease or seeking behavior. So, we included the variable in our analysis model.

3.6.3 The Provider Characteristics

Diabetes patients might visit one or more physician(s) during the study period. The most frequently visited physician in each year was identified as the usual provider.

Age: This variable wais measured with the age of the usual provider at each year during the study period (i.e. year 2004 to 2008). Since we could not get the information of provider seniority, we assumed that older providers were more senior providers. Providers aged 44 years and less were identified as junior providers, and providers aged 45 years and older were identified as senior providers.

Sex: According to the sex of the usual provider, male or female was identified.

Specialty: The specialty of the usual provider was classified to 3 categories: endocrinologist, other specialist, and generalist. Generalists included family physicians and general practitioners. The subspecialists except endocrinologists were coded as other specialists.

3.6.4 The Organization Characteristics:

Ownership: According to the ownership of the healthcare organization which each individual diabetes patient visited most frequently, this variable was classified to 3 categories: public, private non-profit, and private for profit.

Accreditation level: According to the accreditation level of the healthcare organization which each individual diabetes patient visited most frequently, this variable was classified to 4 categories: medical center, regional hospital, district hospital and local clinic.

Governing division of NHIA: To provide more efficient services, NHIA has six regional divisions across Taiwan, i.e. Taipei, Northern, Central, Southern, Kao-Ping, and Eastern Division. Each healthcare organization is governed by one of the six divisions according to the geographic area where the organization is located (Appendix 2). The variable was identified depending on the governing division of each individual organization.

3.6.5 Quality of Diabetes Care

There are several different indicators to assess quality of care. Here, we used process indicators to assess quality of care in diabetes patients.

According to the standards of medical care in diabetes set by American Diabetes Association (ADA) (American Diabetes Association, 2011) and Taiwan Clinical Practice Guidelines for Diabetes Care developed by The Diabetes Association of Republic of China (Taiwan) (DAROC) (DAROC, 2015), diabetes patients are suggested to receive glycated hemoglobin (HbA1C) test at least twice per year if they are in stable status. The frequency of HbA1C test should be increased to quarterly per year if the results of blood test are not meeting the goals or the treatment changes. Except HbA1C test, diabetes patients should receive lipid profile test (including total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL) and triglycerides (TG)), renal function test, urine protein test, eye exam and foot exam at least once per year to assure good quality of care. Because of data limitation, we can't get the information of foot exam from our data source. The process measures of our study were the proportion of patients with HbA1C test at least twice per year, lipid profile test at least once per year, renal function test at least once per year, urine test to detect urine protein at least once per year, and eye exam at least once per year.

3.6.6 Clinical Outcomes: diabetes-related emergency visits and hospitalizations

We chose diabetes-related emergency room (ER) visits and hospitalizations as indicators to assess clinical outcomes.

Diabetes-related ER visits and hospitalizations are defined as the claims data with any diagnoses code of ICD-9-CM 250.0-250.9 or ICD-9 A-code A181. But, ER visits and hospitalizations with a principle code of E-code or cancer will be excluded.

3.6.7 Diabetes-related Healthcare Costs

The money spent on diabetes-related care, including OPD services, emergency visit(s), and hospitalization(s) were calculated by year and then summed up as total healthcare costs.

3.7 Statistical Analysis

3.7.1 Descriptive Statistics

Firstly, the characteristics of the patients, the usual providers, and the usually visited organizations would be described. The time-independent variables (including the patient's age at baseline, sex and income level) were presented with the information in 2004. The time-dependent variables (including patient's residence, disease complexity, enrollment in P4P program or not, total number of diabetes-related visit; usual provider's age, sex and specialty; type and grade of usually visited organization) were presented year by year. Variables with continuous scale will be presented as mean and standard deviation (SD). Variables with categorical scale will be presented as number and percentage.

The trend of provider continuity, proportion of patients with recommended diabetes-specific tests or exams, diabetes-related emergency visits or hospitalizations rates, and diabetes-related healthcare costs were also presented.

3.7.2 Bi-variate Analysis

We used the Chi-Square test for categorical variables and Student's t-test or continuous variables to examine if difference exists between high continuity group and low continuity group.

3.7.3 Logistic Regression

We used logistic regression models to test hypothesis 1, 2 and 3 because the dependent variables were dichotomous variable. For each hypothesis, unadjusted analysis was done first to examine the relationship between dependent and independent variables, and then multivariate analysis was performed to see if the relationship changed after controlling the confounding factors or covariates.

3.7.4 Linear Regression

We used linear regression models to examine the relationship between healthcare costs and continuity of care. Both unadjusted analysis t and multivariate analysis were done to assess the effect of continuity on healthcare costs.

Since we were interested in population-averaged effect and our study design was longitudinal data analysis, we used generalized estimating equations (GEEs) to account for correlated multiple-year data.

The statistical methods used in our study are listed in Table 3.2.

Our analyses were done with Stata 11.2 (StataCorp, College Station, Texas) and SAS version 9.4 (SAS Institute, Cary, North Carolina). P-value less than 0.05 was considered to be statistically significant.

Table 3.2: Statistical methods by hypotheses

Hypothesis	**Dependent variable(s)**	**Independent variable(s)**	**Statistical analysis**
H1	Provider continuity (UPC≧0.75 vs. <0.75)	Patient characteristics Provider characteristics Organization characteristics	1. Chi-square test 2. Logistic regression models with GEE(s) analysis
H2	Process indicators of quality of diabetes care	Provider continuity (UPC) Patient characteristics Provider characteristics Organization characteristics	Logistic regression models with GEE(s) analysis
H3	Emergency visits (yes/no) Hospitalizations (yes/no)	Provider continuity (UPC) Patient characteristics Provider characteristics Organization characteristics	Logistic regression models with GEE(s) analysis
H4	Diabetes-related healthcare costs	Provider continuity (UPC) Patient characteristics Provider characteristics Organization characteristics	Linear regression models with GEE(s) analysis

Chapter 4: Research Results

4.1 Descriptive Statistics

According to the sampling process showed in Figure 3.3, there were 16,596 diabetes patients enrolled in our study. All five-year data of the 16,596 diabetes patients among 2004 to 2008 were collected for statistical analysis.

4.1.1 Characteristics of Study Populations:

The characteristics of study population are presented in Table 4.1 & 4.2. The 16,596 patients aged 19-94 years in 2004, and the mean age was 61.84±11.56 years. Around half of the patients (49.7%, n=8,246) aged 45-64 years and 43.6% (n=7,228) aged 65 years and older in 2004. Only 6.8% (n=1,122) aged 19-44 years in 2004. More than half of the patients (54.7%, n=9,080) were female, and 45.3% (n=7,516) were male. Of the 16,596 patients, 47.8% (n=7,930) were identified as medium income level in 2004. The percentage of low income level and high income level were 22.7% (n=3,772) and 29.5% (n=4,894) respectively.

In 2004, most people (69.3%, n=11,508) lived in urban areas, 23.7% (n=3.937) of patients lived in suburban areas and 6.9% (n=1,151) of patients lived in rural areas. The distribution seemed stable during the study period except few people moved from rural or urban areas to suburban areas. About the disease complexity, 59.2% (n=9,816) of diabetes patients were identified as diabetes without comorbidity in 2004; 32.1%

(n=5,324) suffered from one comorbidity and 8.8% (n=1,456) suffered from two and more comorbidities. During 2004 to 2008, the number and percentage of diabetes patients without comorbidity were decreased; on the contrary, diabetes patient with cormorbidities were increased with time. There were around 20% (n=3,312) of diabetes patients enrolled in P4P program in 2004. The percentage was increased to 24% in 2005 and kept stable between 2005 and 2008. Averagely, each diabetes patient had 10.83 diabetes-related OPD visits per year in 2004. Diabetes-related OPD visits were decreased slightly with time. The mean of diabetes-related OPD visits for each patient was 10.49, 9.82, 9.38 and 8.94 in 2005, 2006, 2007, and 2008 respectively.

Table 4.1: Characteristics of study population in 2004 (16,596 patients)

Variable	Value
Age	
Min, Max	19, 94
Mean (SD)	61.84 (11.56)
Age group (N, (%))	
19-44 y/o	1,122 (6.8%)
45-64 y/o	8,246 (49.7%)
≧65y/o	7,228 (43.6%)
Sex (N, (%))	
Male	7,516 (45.3%)
Female	9,080 (54.7%)
Income status (N, (%))	
Low	3,772 (22.7%)
Medium	7,930 (47.8%)
High	4,894 (29.5%)

Table 4.2: Characteristics of study population by year (16,596 patients)

Variable	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008
Residence (N, (%))					
Urban	11,508 (69.3%)	11,360 (68.5%)	11,390 (68.6%)	11,439 (68.9%)	11,508 (69.3%)
Suburban	3,937 (23.7%)	4,101 (24.7%)	4,091 (24.7%)	4,088 (24.6%)	4,070 (24.5%)
Rural	1,151 (6.9%)	1,135 (6.8%)	1,115 (6.7%)	1,069(6.4%)	1,018 (6.1%)
Disease Complexity (N, (%))					
Low	9,816 (59.2%)	9,639 (58.1%)	9,531 (57.4%)	9,221 (55.6%)	9,137 (55.1%)
Medium	5,324 (32.1%)	5,351 (32.2%)	5,443 (32.88%)	5,609 (33.8%)	5,557 (33.5%)
High	1,456 (8.8%)	1,606 (9.7%)	1,622 (9.8%)	1,766 (10.6%)	1,902 (11.5%)
Enrolled in Pay for Performance (P4P) program (N, (%))					
Yes	3,312 (20.0%)	3,935 (23.7%)	4,049 (24.4%)	4,058 (24.5%)	3,990 (24.0%)
No	13,284 (80.0%)	12,661 (76.3%)	12,547 (75.6%)	12,538 (75.5%)	12,606 (76.0%)
Diabetes-related visits					
Min, Max	4, 70	4, 60	4, 66	4, 58	4, 51
Median	11	10	9	9	8
Mean(SD)	10.83 (4.51)	10.49 (4.57)	9.82 (4.45)	9.38 (4.28)	8.94 (4.27)

4.1.2 Characteristics of Usual Providers

Each diabetes patient might visit only one or several different physicians for diabetes care during the study period. The most frequently visited physician in each year was identified as the usual provider. Each diabetes patients had an identified usual provider in each year. There were 16,596 diabetes patients enrolled in our study, and therefore there were 16,596 usual providers identified in each year.

The characteristics of usual providers are presented in Table 4.3. The majority of usual providers were male. In 2004, 89% (n=14,770) of the 16,596 usual providers were male and only 11% (n=1,826) were female. The proportion of female providers was increased slightly with time, and 12.3% (n=2,047) of the usual providers were female in 2008.

The mean age of usual providers was 45.31±7.81 years in 2004, and was increased with time. The mean age of usual providers was 45.84±7.82, 46.41±7.94, 46.97±8.06 and 47.41±8.24 years in 2005 2006, 2007, and 2008 respectively. More than half of usual providers (51.9%, n=8,611) aged less than 45 years, and 48.1% (n=7,985) of usual providers aged 45 years and older in 2004. With time, the proportion of senior providers was increased significantly. There were 62.9% (n=10,436) of usual providers aged 45 years and older in 2008.

Table 4.3: Characteristics of usual providers by year (16,596 patients)

Variable	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008
Sex (N, (%))					
Male	14,770 (89.0%)	14,686 (88.5%)	14,695 (88.5%)	14,644 (88.2%)	14,549 (87.7%)
Female	1,826 (11.0%)	1,910 (11.5%)	1,901 (11.5%)	1,952 (11.8%)	2,047 (12.3%)
Age					
Min, Max	26, 87	26, 83	28, 86	27, 85	26, 86
Mean(SD)	45.31 (7.81)	45.84 (7.82)	46.41 (7.94)	46.97 (8.06)	47.41 (8.24)
Age group					
<45 y/o	8,611 (51.9%)	7,948 (47. 9%)	7,380 (44.5%)	6,627 (39.9%)	6,160 (37.1%)
≧45 y/o	7,985(48.1%)	8,648 (52.1%)	9,216 (55.5%)	9,969 (60.1%)	10,436 (62.9%)
Specialty (N, (%))					
Generalists	8,491 (51.2%)	8,247 (49.9%)	7,839 (47.2%)	7,508 (45.2%)	7,150 (43.1%)
Endocrinologists	4,874 (29.4%)	5,085 (30.6%)	5,428 (32.7%)	5,617 (33.9%)	5,768 (34.8%)
Other subspecialists	3,231 (19.5%)	3,237 (19.5%)	3,329 (20.1%)	3,471 (20.9%)	3,678 (22.2%)

In 2004, 51.2% (n=8,491) of usual providers were generalists, 29.4% (n=4,874) were endocrinologists, and 19.5% (n=3,231) were other subspecialists. The proportion of generalists was decreased, but the proportion of endocrinologists was increased notably year by year. The proportion of other subspecialists was increased slightly with time. In 2008, 43.1% (n=7,150) of usual providers were generalists, 34.8% (n=5,768) were endocrinologists, and 22.2% (n=3,678) were other subspecialists.

4.1.3 Characteristics of Organizations

The characteristics of health organizations which diabetes patients visited the most frequently in each year are presented in Table 4.4. In 2004, 28.2% (n=4,683) of patients usually visited public organizations, 33.6% (n=5,580) visited private non-profit organizations, and 38.2% (n=6,333) visited private profit organizations for help. With time, the proportion of private non-profit organizations was increased, but the proportion of private profit organizations was decreased. The change was more significant between 2007 and 2008. In terms of accreditation level of health organizations, 30.2% (n=5,009) of diabetes patients usually visited local clinics, 24.5% (n=4,061) visited medical centers, 25.6% (n=4,250) visited regional hospitals and 19.7% (n=3,276) visited district hospitals for help in 2004. The proportion of diabetes patients cared for at local clinics and medical centers was relatively stable during 2004 to 2008. There were more patients cared for at regional hospitals, but

Table 4.4: Characteristics of the usually visited health organizations by year (16,596 patients)

Variable	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008
Ownership (N, (%))					
Public	4,683 (28.2%)	4,571 (27.5%)	4,546 (27.4%)	4,534 (27.3%)	4,509 (27.2%)
Private non-profit	5,580 (33.6%)	5,590 (33.7%)	5,642 (34.0%)	5,902 (35.6%)	6,518 (39.3%)
Private profit	6,333 (38.2%)	6,435 (38.8%)	6,408 (38.6%)	6,160 (37.1%)	5,569 (33.6%)
Accreditation Level (N, (%))					
Local Clinic	5,009 (30.2%)	5,052 (30.4%)	5,120 (30.9%)	5,008 (30.2%)	4,889 (29.5%)
Medical Center	4,061 (24.5%)	3,889 (23.4%)	4,136 (24.9%)	4,175 (25.2%)	4,203 (25.3%)
Regional Hospital	4,250 (25.6%)	4,432 (26.7%)	4,148 (25.0%)	4,410 (26.6%)	4,680 (28.2%)
District Hospital	3,276 (19.7%)	3,223 (19.4%)	3,192 (19.2%)	3,003 (18.1%)	2,824 (17.0%)
Governing Division of NHIA (N, (%))					
Taipei	5,024 (30.3%)	5,035 (30.3%)	5,042 (30.4%)	5,045 (30.4%)	5,068 (30.5%)
Northern	2,381 (14.3%)	2,385 (14.4%)	2,371 (14.3%)	2,357 (14.2%)	2,345 (14.1%)
Central	3,290 (19.8%)	3,291 (19.8%)	3,287 (19.8%)	3,281 (19.8%)	3,277 (19.8%)
Southern	2,626 (15.8%)	2,621(15.8%)	2,622 (15.8%)	2,641 (15.9%)	2,658 (16.0%)
Kao-Ping	2,876 (17.3%)	2,869 (17.3%)	2,877 (17.3%)	2,871 (17.3%)	2,848 (17.2%)
Eastern	399 (2.4%)	395 (2.4%)	397 (2.4%)	401 (2.4%)	400 (2.4%)

fewer patients cared for at district hospitals in 2008 compared with 2004.

In 2004, 30.3% (n=5,024) of patients usually visited the health organizations governed by Taipei Division of NHIA, 14.4% (n=2,381) by Northern Division, 19.8% (n=3,290) by Central Division, 15.8% (n=2,626) by Southern Division, 17.3% (n=2,876) by Kao-Ping Division and 2.4% (n=399) by Eastern Division. The proportion did not vary much during 2004 to 2008.

4.1.4 Index of Continuity of Care—UPC

We used UPC (usual provider continuity) to represent the index of continuity of care. The distribution of UPC is presented in Table 4.5. Of the 16,596 diabetes patients, 33.7% (n=5,597) were identified as low continuity group (i.e. UPC<0.75), and 66.3% (n=10,999) were high continuity group (i.e. UPC≧0.75) in 2004. The proportion of low continuity group was decreased, but high continuity group was increased year by year. In 2008, 28% (n=4,644) of the diabetes patients were identified as low continuity group, and 72% (n=11,952) were high continuity group.

Table 4.5: Distribution of index of continuity of care -- UPC by year (16,596 patients)

Variable	**Year 2004**	**Year 2005**	**Year 2006**	**Year 2007**	**Year 2008**
Low continuity (UPC<0.75)					
N	5,597	5,296	4,808	4,698	4,644
%	33.7%	31.9%	29.0%	28.3%	28.0%
High continuity (UPC≧0.75)					
N	10,999	11,300	11,788	11,898	11,952
%	66.3%	68.1%	71.0%	71.7%	72.0%

4.1.5 Quality of Diabetes Care

According to the clinical practice guidelines developed by ADA and DAROC, diabetes patients should receive some specific tests and exams periodically to ensure good quality of care. HbA1C testing for at least twice yearly; fasting lipid profile testing, renal function testing, urine-protein testing and eye exam for at least once yearly are recommended by the guidelines. Table 4.6 showed the distribution of patients receiving recommended diabetes-specific tests or exams.

In our study, we found the frequency of receiving HbA1C test varied greatly for diabetes patients. Some people did not receive any HbA1C test, but some patients received HbA1C test for 19 times during a whole year. In 2004, each diabetes patient averagely received HbA1C test for around twice yearly. The frequency of receiving HbA1C test yearly was increased year by year. In 2008, each diabetes patient averagely received HbA1C test for around three times yearly.

In 2004, 71.7% (n=11,902) of the diabetes patients met the criteria of guidelines to receive at least 2 times of HbA1C test yearly. The proportion of diabetes patients receiving HbA1C tests according to the recommendations of guidelines was increased significantly year by year. The increment was around 3% to 5% per year. There were 74.9%, 79.9%, 85.7%, and 88.1% of patients receiving HbA1C test for at least twice yearly in 2005, 2006, 2007, and 2008 respectively.

Table 4.6: Distribution of diabetes patients receiving process quality indicators of diabetes care by year (16,596 patients)

Variable	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008
HbA1C test					
Min, Max	0, 19	0, 17	0, 14	0, 15	0, 16
Mean(SD)	1.97 (1.80)	2.09 (1.78)	2. 31 (1.78)	2.73 (1.96)	2.90 (1.95)
HbA1C test (N, (%))					
≧2	11,902(71.7%)	12,426 (74.9%)	13,262 (79.9%)	14,227 (85.7%)	14,617 (88.1%)
<2	4,694 (28.3%)	4,170 (25.1%)	3,334 (20.1%)	2,369 (14.3%)	1,979 (11.9%)
Lipid profile test (N, (%))					
≧1	12,334 (74.3%)	12,364 (74.5%)	12,650 (76.2%)	13,405 (80.8%)	13,743 (82.8%)
0	4,262 (25.7%)	4,232 (25.5%)	3,946 (23.8%)	3,191 (19.2%)	2,853 (17.2%)
Creatinine test (N, (%))					
≧1	11,422 (68.8%)	11,668 (70.3%)	12,023 (72.4%)	12,693 (76.5%)	13,591 (81.9%)
0	5,174 (31.2%)	4,928 (29.7%)	4,573 (27.6%)	3,903 (23.5 %)	3,005 (18.1%)
Urinalysis test (N, (%))					
≧1	3,425 (20.6%)	3,704 (22.3%)	3,641 (21.9%)	3,331 (20.1%)	3,187 (19.2%)
0	13,171 (79.4%)	12,892 (77.7%)	12,955 (78.1%)	13,265 (79.9%)	13,409 (80.8%)
Eye exam (N, (%))					
≧1	3,647 (22.0%)	3,732 (22.5%)	3,690 (22.2%)	3,596 (21.7%)	3,641 (21.9%)
0	12,949 (78.0%)	12,864 (77.5%)	12,906 (77.8%)	13,000 (78. 3%)	12,955 (78.1%)

Of all the diabetes patients, 74.3% (n=12,334) had received fasting lipid profile test for at least once in 2004. The proportion of diabetes patients receiving lipid profile test according to the recommendations of guidelines was also increased with time. The increment is especially significant between 2006 and 2007. Up to 82.8% (n=13,743) of patients receiving fasting lipid profile test for at least once in 2008.

Of all the diabetes patients, 68.8% (n=11,422) had received creatinine test (a proxy of renal function test) for at least once in 2004. The proportion of patients receiving creatinine test according to the recommendations of guidelines was also increased with time. The increment is especially significant after year 2006. There were 81.9% (n=13,591) of diabetes patients receiving creatinine test for at least once in 2008.

The proportion of receiving urine test to detect urine protein excretion according to the recommendations of guidelines was relatively low compared with above blood tests. One-fifth (20.6%, n=3,425) of diabetes patients had received urine test for at least once in 2004. The proportion of diabetes patients receiving urine test according to the recommendations of guidelines did not vary much year by year. It was 22.3%, 21.9%, 20.1%, and 19.2% in 2005, 2006, 2007 and 2008 respectively.

The proportion of receiving eye exam according to the recommendations of guidelines was also low and stable with time. It was 22%, 22.5%, 22.2%, 21.7%, and 21.9% in 2004, 2005, 2006, 2007 and 2008 respectively.

4.1.6 Diabetes-related Health Outcomes

We used diabetes-related emergency visits and hospitalizations as the indicators of diabetes-related health outcomes. Table 4.7 showed diabetes-related emergency visits and hospitalizations each year during 2004 to 2008. In 2004, 3.40% (n=565) of diabetes patients had emergency visits. The proportion of diabetes-related emergency visits was 3.72%, 3.51%, 3.92%, and 4.37% in 2005, 2006, 2007, and 2008 respectively. Only 0.96% (n=160) of patients had been hospitalized due to diabetes-related conditions or complications in 2004. The proportion of diabetes-related hospitalizations was 0.89%, 0.85%, 0.88% and 0.88% in 2005, 2006, 2007, and 2008 respectively.

Table 4.7: Distribution of diabetes-related emergency visit(s) or hospitalization(s) by year (16,596 patients)

Variable	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008
Emergency visit(s) (N, (%))					
Yes	565 (3.40%)	618 (3.72%)	582 (3.51%)	650 (3.92%)	726 (4.37%)
No	16,031 (96.60%)	15,978 (96.28%)	16,014 (96.49%)	15,964 (96.08%)	15,870 (95.63%)
Hospitalization(s) (N, (%))					
Yes	160 (0.96%)	147 (0.89%)	141 (0.85%)	146 (0.88%)	146 (0.88%)
No	16,436 (99.04%)	16,449 (99.11%)	16,455 (99.15%)	16,450 (99.12%)	16,450 (99.12%)

4.1.7 Diabetes-related Healthcare Costs

Table 4.8 showed diabetes-related healthcare costs according to year. Diabetes-related healthcare costs varied greatly among diabetes patients. The yearly total costs ranged between $1,110 NTD ($35 USD) and $618,721 NTD ($19,335 USD). In 2004, the mean of yearly total diabetes-related healthcare costs was $23,004 NTD ($719 USD). The mean of yearly total costs was decreased with time. It was $22,205 NTD ($694 USD), $21,658 NTD ($677 USD), $20,713 NTD ($647 USD), and $20,659 NTD ($646 USD) in 2005, 2006, 2007, and 2008 respectively.

The most of diabetes-related healthcare costs was spent on OPD department (OPD) services. The mean of yearly OPD costs was $22,476 NTD ($702 USD), $21,627 NTD ($676 USD), $21,009 NTD ($657 USD), $20,096 NTD ($628 USD), and $19,967 NTD ($624 USD) in 2004, 2005, 2006, 2007, and 2008 respectively. OPD costs included medication costs, diagnostic costs and treatment costs. Among OPD costs, medication costs were the majority and followed by treatment costs. The details of OPD medication, diagnostic and treatment costs each year were also listed in Table 4.8.

For those diabetes patients who had emergency visits, yearly emergency costs ranged from $200 NTD ($6 USD) to $95,979 NTD ($2,999 USD). In 2004, the mean of yearly emergency costs for those who had diabetes-related emergency visits was

$3,627 NTD ($113 USD). It was increased year by year, and was $3,715 NTD ($116 USD), $3,965 NTD ($124 USD), $4,272 NTD ($134 USD) and $4,975 NTD ($155 USD) in 2005, 2006, 2007, and 2008 respectively.

For those diabetes patients who had been hospitalized due to diabetes-related conditions or complications, yearly hospitalization costs ranged from $2,690 NTD ($84 USD) to 504,364 NTD ($15,761 USD). The mean of yearly hospitalization costs for those who had diabetes-related hospitalizations was $41,888 NTD ($1,309 USD), $49,611 NTD ($1,550 USD), $59,965 NTD ($1,874 USD), $51,469 NTD ($1,608 USD) and $53,989 NTD ($1,687 USD) in 2004, 2005, 2006, 2007, and 2008 respectively.

Table 4.8: Diabetes-related healthcare costs by year

Variable	Year 2004	Year 2005	Year 2006	Year 2007	Year 2008
Total costs *(NTD) (N=16,596)					
Min, Max	1,218 614,870	1,140 618,721	1,110 592,082	1,130 450,404	1,480 520,062
Mean(SD)	23,004 (18,448)	22,205 (17,918)	21,658 (17,820)	20,713 (16,113)	20,659 (17,809)
OPD costs (NTD) (N=16,596)					
Min, Max	1,218 614,870	1,140 618,721	1,110 592,082	1,130 450,404	1,480 520,062
Mean(SD)	22,476 (16,985)	21,627 (16,186)	21,009 (15,132)	20,096 (14,385)	19,967 (15610)
Medication costs (NTD) (N=16,596)					
Min, Max	0 608,221	0 609,577	0 585,268	0 445,385	0 457,903
Mean(SD)	17,235 (15,526)	16240 (14,665)	15,552 (13,666)	14,537 (12,959)	14,293 (14,100)
Diagnostic costs (NTD) (N=16,596)					
Min, Max	0 15,119	0 14,058	0 15,900	0 13,336	0 15,382
Mean(SD)	2,616 (1,077)	2,590 (1,090)	2,617 (1,078)	2,629 (1,061)	2,597 (1,102)
Treatment costs (NTD) (N=16,596)					
Min, Max	0 220,920	0 181,718	0 179,602	0 90,130	0 119,140
Mean(SD)	2,626 (3,224)	2,797 (3,455)	2,840 (3,436)	2,929 (3,173)	3,077 (3,329)
Emergency costs (NTD) (patients without emergency visit(s) were excluded)					
Min, Max	418 33,026	438 45,641	200 21,748	458 95,979	507 44,672
N	565	618	582	650	726
Mean(SD)	3,627 (3,966)	3,715 (4,215)	3,965 (3,622)	4,272 (5,388)	4,975 (5,394)
Hospitalization costs (NTD) (patients without hospitalization(s) were excluded)					
Min, Max	2,745 504,364	2,690 311,001	4,224 437,525	5,356 259,512	4,269 387,420
N	160	147	141	145	146
Mean(SD)	41,888 (56,226)	49,611 (62,371)	59,965 (80,692)	51,469 (53,537)	53,989 (68,046)

*All costs are presented with NTD (New Taiwan Dollar). 32NTD = 1USD (United States Dollar)

4.2 Bi-variate Analysis to Examine the Relationships between UPC and the Patient/Provider/Organization Characteristics

We used UPC=0.75 as the cut-point of continuity of care. UPC≧0.75 was defined as high continuity of care, and UPC<0.75 was defined as low continuity of care. Chi-Square test and student t-test were applied to compare the distribution of patient characteristics, provider characteristics, and organization characteristics between high continuity group and low continuity group. There were significant differences (P<0.001) between high continuity group and low continuity group for patients' age in 2004, patients' income status, residence, disease complexity, enrolled in P4P program or not and total number of diabetes-related visit per year. There was small difference (P=0.035) between the two groups for patients' sex. There were also significant differences (P<0.001) between the two groups for the usual providers' age, specialty, usually visited organizations' type, grade and governing division, but there was no significant difference (P=0.797) for the usual providers' sex. The results are showed on Table 4.9.

Table 4.9: The distribution of patient, provider, organization characteristics by continuity of care (low continuity vs. high continuity)

	Low continuity (UPC<0.75)		High continuity (UPC≧0.75)		Chi-square test	P
Patient characteristics						
Age in 2004 (N, (%))						
19-44 y/o	1,626	(29%)	3,984	(71%)	35.62	<0.001
45-64 y/o	12,121	(29%)	29,109	(71%)		
≧65 y/o	11,296	(31%)	24,844	(69%)		
Sex (N, (%))						
Male	11,480	(46%)	13,563	(54%)	4.43	0.035
Female	26,100	(45%)	31,837	(55%)		
Income level (N, (%))						
Low	6,267	(33%)	12,593	(67%)	150.53	<0.001
Medium	11,980	(30%)	27,670	(70%)		
High	6,796	(28%)	17,674	(72%)		
Residence (N, (%))						
Urban	16,467	(29%)	40,738	(71%)	171.33	<0.001
Suburban	6,788	(33%)	13,499	(67%)		
Rural	1,788	(33%)	3,700	(67%)		
Disease Complexity (N, (%))						
Low	12,317	(26%)	35,027	(74%)	1400.00	<0.001
Medium	8,906	(33%)	18,378	(67%)		
High	3,820	(46%)	4,532	(54%)		
Enrolled in P4P program (N, (%))						
No	19,505	(31%)	44,131	(69%)	28.78	<0.001
Yes	5,538	(29%)	13,806	(71%)		
Number of diabetes-related visit (Mean, (SD))						
	10.99	(4.92)	9.42	(4.17)	47.02*	<0.001

*Student-t test

Table 4.9: The distribution of patient, provider, organization characteristics by continuity of care (low continuity vs. high continuity) (continued)

	Low continuity (UPC<0.75)	High continuity (UPC≧0.75)	Chi-square test	P
Provider characteristics				
Age (N, (%))				
26-44 y/o	12,489 (34%)	24,237 (66%)	457.79	<0.001
>=45 y/o	12,554 (27%)	33,700 (73%)		
Sex (N, (%))				
Male	22,124 (30%)	51,220 (70%)	0.07	0.797
Female	2,919 (30%)	6,717 (70%)		
Specialty (N, (%))				
Generalist	13,270 (34%)	25,992 (66%)	749.01	<0.001
Endocrinologist	6,419 (24%)	20,353 (76%)		
Other subspecialist	5,354 (32%)	11,592 (68%)		
Organization characteristics				
Ownership (N, (%))				
Public	7,243 (32%)	15,600 (68%)	284.27	<0.001
Private non-profit	7,764 (27%)	21,468 (73%)		
Private profit	10,036 (32%)	20,869 (68%)		
Accreditation Level (N, (%))				
Local clinic	7,732 (31%)	17,346 (69%)	715.64	<0.001
Medical center	5,412 (26%)	15,052 (74%)		
Regional H.	5,960 (27%)	15,960 (73%)		
District H.	5,939 (38%)	9,579 (62%)		
Governing Division of NHIA (N, (%))				
Taipei Division	7,197 (29%)	18,017 (71%)	159.02	<0.001
Northern Division	3,612 (31%)	8,227 (69%)		
Central Division	4,738 (29%)	11,688 (71%)		
Southern Division	3,977 (30%)	9,191 (70%)		
Kao-Ping Division	4,781 (33%)	9,560 (67%)		
Eastern Division	738 (37%)	1,254 (63%)		

4.3 Logistic Regression Models with Generalized Estimating Equations (GEEs) to Detect the Determinants of Provider Continuity

To further detect the relationship between provider continuity and explanatory variables, logistic regression models were done. The results of logistic regression models with GEE are showed in Table 4.10. We performed unadjusted analysis for each explanatory variable first. Then we performed multivariate analysis which takes account of all explanatory variables simultaneously to help us understand the relationship between provider continuity and explanatory variables more precisely.

4.3.1 Unadjusted Logistic Regression

4.3.1.1 Patient Characteristics

The odds of high provider continuity were not statistically significantly different between diabetes patients aged 45-64 years and aged 19-44 years (OR: 0.98, 95% CI: 0.90~1.08). However, diabetes patients aged 65 years and older had 10% lower odds of high continuity compared with those who aged 19-44 years (OR: 0.90, 95% CI: 0.82~0.99).

Compared with male patients, female patients had a little higher odds of high continuity, but the difference was not statistically significant (OR: 1.03, 95% CI: 0.99~1.08).

Table 4.10: Logistic regression models with generalized estimating equations (GEEs) to detect the determinants of provider continuity

Dependent variable:	Unadjusted analysis			Adjusted analysis		
UPC (≧0.75 vs. <0.75)	OR	95% CI	p-value	OR	95% CI	p-value
Patient characteristics						
Age at baseline (reference: 19-44 y/o)						
45-64 y/o	0.98	0.90 ~ 1.08	0.697	1.10	1.00 ~ 1.21	0.058
≥65 y/o	0.90	0.82 ~ 0.99	0.023	1.14	1.04 ~ 1.26	0.007
Sex (reference: Male)						
Female	1.03	0.99 ~ 1.08	0.162	1.06	1.01 ~ 1.10	0.016
Income level (reference: Low)						
Medium	1.15	1.09 ~ 1.21	<.001	1.09	1.03 ~ 1.15	0.005
High	1.29	1.22 ~ 1.37	<.001	1.16	1.09 ~ 1.24	<.001
Residence (reference: Urban)						
Sub-urban	0.84	0.80 ~ 0.88	<.001	0.91	0.86 ~ 0.97	0.003
Rural	0.90	0.82 ~ 0.99	0.024	1.03	0.93 ~ 1.14	0.542
Disease complexity (reference: Low)						
Medium	0.73	0.70 ~ 0.75	<.001	0.75	0.72 ~ 0.78	<.001
High	0.46	0.44 ~ 0.49	<.001	0.49	0.47 ~ 0.52	<.001
P4P program (reference: No)						
Yes	0.98	0.94 ~ 1.03	0.136	0.97	0.93 ~ 1.02	0.254
Diabetes-related visits						
	0.92	0.91 ~ 0.92	<.001	0.93	0.92 ~ 0.93	<.001
Provider characteristics						
Age (reference: 26-44 y/o)						
≧45 y/o	1.29	1.25 ~ 1.34	<.001	1.27	1.22 ~ 1.32	<.001
Sex (reference: Male)						
Female	0.94	0.89 ~ 1.00	0.057	0.91	0.85 ~ 0.97	0.003
Specialty (reference: Generalist)						
Endocrinologist	1.45	1.38 ~ 1.52	<.001	1.37	1.28 ~ 1.46	<.001
Other subspecialist	1.04	0.99 ~ 1.10	0.131	1.08	1.01 ~ 1.14	0.021

Table 4.10: Logistic regression models with generalized estimating equations (GEEs) to detect the determinants of provider continuity (continued)

Dependent variable:	Unadjusted analysis			Adjusted analysis		
UPC (≧0.75 vs. <0.75)	OR	95% CI	p-value	OR	95% CI	p-value
Organization characteristics						
Ownership (reference: Public)						
Private Non-profit	1.19	1.13 ~ 1.26	<.001	1.10	1.04 ~ 1.17	0.001
Private Profit	1.00	0.95 ~ 1.06	0.965	1.04	0.98 ~ 1.11	0.193
Accreditation level (reference: Local clinic)						
Medical center	1.11	1.05 ~ 1.18	0.001	0.81	0.74 ~ 0.88	<.001
Regional hospital	1.07	1.01 ~ 1.13	0.030	0.92	0.86 ~ 1.00	0.043
District hospital	0.69	0.65 ~ 0.74	<.001	0.72	0.67 ~ 0.77	<.001
Governing Division of NHIA (reference: Taipei Division)						
Northern Division	0.92	0.85 ~ 0.98	0.016	1.01	0.94 ~ 1.09	0.794
Central Division	0.98	0.92 ~ 1.05	0.633	1.14	1.06 ~ 1.22	<.001
Southern Division	0.92	0.86 ~ 0.98	0.013	0.96	0.89 ~ 1.03	0.276
Kao-Ping Division	0.81	0.76 ~ 0.86	<.001	0.88	0.82 ~ 0.94	<.001
Eastern Division	0.69	0.60 ~ 0.79	<.001	0.82	0.71 ~ 0.94	0.005
Year (reference: 2004)						
2005	1.09	1.05 ~ 1.13	<.001	1.06	1.02 ~ 1.10	0.006
2006	1.25	1.20 ~ 1.30	<.001	1.15	1.10 ~ 1.20	<.001
2007	1.29	1.24 ~ 1.34	<.001	1.14	1.09 ~ 1.19	<.001
2008	1.31	1.26 ~ 1.37	<.001	1.12	1.07 ~ 1.17	<.001

Diabetes patients with medium or high income level had higher odds of high continuity compared with the patients with low income level (OR: 1.15, 95% CI: 1.09~1.21; and OR: 1.29, 95% CI: 1.22~1.37 respectively).

Diabetes patients living in suburban areas had lower odds of high continuity compared with patients living in urban areas (OR: 0.84, 95% CI: 0.80~0.88). Patients living in rural areas also had lower odds of high continuity compared with those living in urban areas, but the difference was less significant (OR: 0.90, 95% CI: 0.82~0.99).

Diabetes patients with medium or high disease complexity significantly had lower odds of high continuity compared with patients with low complexity (OR: 0.73, 95% CI: 0.70~0.75; and OR: 0.46, 95% CI: 0.44~0.49 respectively).

The odds of high continuity were not statistically significantly different between patients enrolled in P4P program and those who were not enrolled in P4P program (OR: 0.98, 95% CI: 0.94~1.03).

The odds of high continuity were 8% decreased whenever diabetes patients increased one diabetes- related visit in each year (OR: 0.92, 95% CI: 0.91~0.92).

4.3.1.2 Provider Characteristics

Diabetes patients had 29% higher odds of high continuity if their usual provider aged 45 years and older compared with those whose usual provider aged 44 years and less (OR: 1.29, 95% CI: 1.25~1.34).

Diabetes patients whose usual provider was a female physician had lower odds of high continuity compared with patients whose usual provider was a male physician, although the difference was not statistically significant (OR: 0.94, 95% CI: 0.89~1.00).

Diabetes patients had 45% higher odds of high continuity if their usual provider was an endocrinologists compared with those whose usual provider was a generalist (OR: 1.45, 95% CI: 1.38~1.52). Diabetes patients whose usual provider was an other subspecialist had a little higher odds of high continuity compared with those whose usual provider was a generalist (OR: 1.04, 95% CI: 0.99~1.10). However, the difference was not statistically significant.

4.3.1.3 Organization Characteristics

Diabetes patients who usually visited private a non-profit organization had higher odds of high continuity compared with patients usually visited a public organization (OR: 1.19, 95% CI: 1.13~1.26). The odds of having high continuity was similar between patients who usually visited a private profit organization and patients who usually visit a public organization (OR: 1.00, 95% CI: 0.95~1.06).

Diabetes patients who usually visited a medical center or a regional hospital had higher odds of high continuity compared with those who usually visited a local clinic (OR: 1.11, 95% CI: 1.05~1/18; and OR: 1.07, 95% CI: 1.01~1.13 respectively).

However, diabetes patients who usually visited a district hospital had 31% lower odds of high continuity compared with those who usually visited a local clinic (OR: 0.69, 95% CI: 0.65~0.74).

Compared diabetes patients usually visited a health organization governed by Taipei Division of BNHI, patients usually visited a health organization governed by Northern, Southern, Kao-Ping or Eastern Division of NHIA had lower odds of high continuity (OR: 0.92, 95% CI: 0.85~0.98; OR: 0.92, 95% CI: 0.86~0.98; OR: 0.81, 95% CI: 0.76~0.86; and OR: 0.69, 95% CI: 0.60~0.79 respectively). Diabetes patients usually visited a health organization governed by Central Division also had lower odds of high continuity; however, the difference was not statistically significant (OR: 0.98, 95% CI: 0.92~1.05).

4.3.1.4 The Time Trends

Compared with year 2004, diabetes patients had higher odds of high provider continuity (i.e. UPC≧0.75) in 2005 (OR: 1.09, 95% CI: 1.05~1.13), 2006 (OR: 1.25, 95% CI: 1.20~1.30), 2007 (OR: 1.29, 95% CI: 1.24~1.34), and 2008 (OR: 1.31, 95% CI: 1.26~1.37).

4.3.2 Adjusted Logistic Regression

4.3.2.1 Patient Characteristics

After controlling for all other covariates, diabetes patients aged 45-64 years seemed have higher odds of high continuity compared with patients aged 19-44 years, but the difference was not statistically significant (OR: 1.10, 95% CI: 1.00~1.21). However, patients aged 65 years and older did have higher odds of high continuity compared with patients aged 19-44 years (OR: 1.14, 95% CI: 1.04~1.26). The results were different from those we got with unadjusted analysis. Female patients had higher odds of high continuity compared with male patients (OR: 1.06, 95% CI: 1.01~1.10). Diabetes patients with medium or high income level still had higher odds of high continuity compared with those who with low income level (OR: 1.09, 95% CI: 1.03~1.15; and OR: 1.16, 95% CI: 1.09~1.24 respectively). Diabetes patients living in suburban areas still had lower odds of high continuity compared with patients lived in urban areas (OR: 0.91, 95% CI: 0.86~0.97). Diabetes patients living in rural areas seemed have a little higher odds of high continuity compared with patients living in urban areas; however, the difference was not statistically significant (OR: 1.03, 95% CI: 0.93~1.14). Diabetes patients with medium or high disease complexity still had lower odds of high continuity compared with patients with low complexity (OR: 0.75, 95% CI: 0.72~0.49; and OR: 0.49, 95% CI: 0.47~0.5 respectively). The odds of high

continuity was not statistically significantly different between patients enrolled in P4P program and those who were not enrolled in P4P program (OR: 0.97, 95% CI: 0.93~1.02). The odds of high continuity was decreased when patients increased one diabetes-related visit in each year (OR: 0.93, 95% CI: 0.92~0.93).

4.3.2.2 Provider Characteristics

After controlling for other covariates, diabetes patients whose usual provider aged 45 years and older still had higher odds of high continuity compared with those whose usual provider aged 44 years and less (OR: 1.27, 95% CI: 1.22~1.32). Diabetes patients whose usual provider was a female physician had lower odds of high continuity compared with those whose usual provider was a male physician (OR: 0.91, 95% CI: 0.85~0.97). Diabetes patients whose usual provider was an endocrinologist or an other subspecialist had higher odds of high continuity compared with those whose usual provider was a generalist (OR: 1.37, 95% CI: 1.28~1.46; and OR: 1.08, 95% CI: 1.01~1.14).

4.3.2.3 Organization Characteristics

After controlling for other covariates, diabetes patients who usually visited a private non-profit organization still had higher odds of high continuity compared with patients usually visited a public organization (OR: 1.10, 95% CI: 1.04~1.17). Diabetes patients who usually visited a private profit organization seemed have higher odds of

high continuity compared with patients usually visited a public organization, but the difference was not statistically significant (OR: 1.04, 95% CI: 0.98~1.11). These results were comparable to those we got in unadjusted analysis. However, we found that diabetes patients who usually visited a medical center or a regional hospital had lower odds of high continuity compared with those who usually visited a local clinic (OR: 0.81, 95% CI: 0.74~0.88; OR: 0.92, 95% CI: 0.86~1.00 respectively). The results were different from those we got in unadjusted analysis. Diabetes patients who usually visited a district hospital still had lower odds of high continuity compared with those who usually visited a local clinic (OR: 0.72, 95% CI: 0.67~0.77). The result was comparable to that we got in unadjusted analysis.

Under adjusted model, diabetes patients usually visited a health organization governed by Northern or Southern Division of NHIA had similar odds of high continuity compared with those who usually visited a health organization governed by Taipei Division because the difference was not statistically significant (OR: 1.01, 95% CI: 0.94~1.09; and OR: 0.96, 95% CI: 0.89~1.03 respectively). Diabetes patients who usually visited a health organization governed by Central Division had higher odds of high continuity compared with those who usually visited a health organization governed by Taipei Division (OR: 1.14, 95% CI: 1.06~1.22). These results were different from those we got in unadjusted analysis. However, diabetes patients who

usually visited a health organization governed by Kao-Ping or Eastern Division of NHIA still had lower odds of high continuity compared with those who usually visited a health organization governed by Taipei Division (OR: 0.88, 95% CI: 0.82~0.94; and OR: 0.82, 95% CI: 0.71~0.94 respectively). The result was comparable to that we got in unadjusted analysis.

4.3.2.4 The Time Trends

After controlling for patient, provider and organization characteristics, diabetes patients still had higher odds of high continuity in 2005 (OR: 1.06, 95% CI: 1.02~1.10), 2006 (OR: 1.15, 95% CI: 1.10~1.20), 2007 (OR: 1.14, 95% CI: 1.09~1.19), and 2008 (OR: 1.12, 95% CI: 1.07~1.17) compared with year 2004.

4.4 Logistic Regression Models with Generalized Estimating Equation (GEEs) to Examine the Effect of Provider Continuity on Quality of Diabetes Care

According to the clinical practice guidelines, diabetes patients should receive specific diabetes-related blood tests, urine test and eye exam periodically to assure quality of care.

4.4.1 Diabetes-related Blood Tests

Diabetes patients are suggested to receive HbA1C test at least twice per year, lipid profile test (including total cholesterol, triglyceride, high-density lipoprotein (HDL) or low-density lipoprotein (LDL)) at least once per year and renal function test (i.e. creatinine test) at least once per year. The effects of continuity of care on receiving recommended annual diabetes-related blood tests are showed in Table 4.11.

4.4.1.1 Unadjusted Logistic Regression

Under unadjusted analysis, the odds of receiving HbA1C test at least twice per year were not statistically significantly different between high continuity patients and low continuity patients (OR: 1.01, 95% CI: 0.97~1.04). But high continuity patients had much lower odds of receiving annual lipid profile test and receiving annual renal function test compared with low continuity patients (OR: 0.81, 95% CI: 0.78~0.84; and OR: 0.72, 95% CI: 0.69~0.74 respectively).

Table 4.11: Logistic regression models with GEE(s) to examine the effects of provider continuity on process indicators of quality of diabetes care: diabetes-related blood tests

Variable	Annual HbA1C Test (≧2 vs <2)				Annual Lipid Test (≧1 vs 0)				Annual Creatinine Test (≧1 vs 0)			
	OR	95% CI		P-Value	OR	95% CI		P-Value	OR	95% CI		P-Value
Unadjusted analysis												
UPC (reference: <0.75)												
≧0.75	1.01	0.97	~ 1.04	0.723	0.81	0.78	~ 0.84	<.001	0.72	0.69	~ 0.74	<.001
Adjusted analysis												
UPC (reference: <0.75)												
≧0.75	1.07	1.03	~ 1.12	<.001	0.86	0.83	~ 0.90	<.001	0.74	0.71	~ 0.77	<.001
Patient characteristics												
Age at baseline (reference: 19-44 y/o)												
45-64 y/o	1.05	0.94	~ 1.16	0.406	1.35	1.21	~ 1.50	<.001	1.25	1.14	~ 1.37	<.001
≧65 y/o	0.79	0.71	~ 0.88	<.001	0.97	0.87	~ 1.08	0.601	1.32	1.20	~ 1.45	<.001
Sex (reference: Male)												
Female	1.00	0.95	~ 1.05	0.919	1.11	1.06	~ 1.17	<.001	1.04	0.99	~ 1.08	0.155
Income level (reference: Low)												
Medium	0.93	0.87	~ 0.99	0.031	0.98	0.92	~ 1.05	0.627	1.00	0.94	~ 1.06	0.868
High	1.12	1.04	~ 1.20	0.002	1.16	1.08	~ 1.25	<.001	1.03	0.96	~ 1.10	0.399
Residence (reference: Urban)												
Suburban	0.82	0.77	~ 0.87	<.001	0.82	0.77	~ 0.87	<.001	0.78	0.73	~ 0.82	<.001
Rural	0.68	0.62	~ 0.75	<.001	0.68	0.61	~ 0.75	<.001	0.62	0.56	~ 0.68	<.001

Table 4.11: Logistic regression models with GEE(s) to examine the effects of provider continuity on process indicators of quality of diabetes care: diabetes-related blood tests (continued)

Variable	Annual HbA1C Test (≧2 vs <2)			Annual Lipid Test (≧1 vs 0)			Annual Creatinine Test (≧1 vs 0)		
	OR	95% CI	P-Value	OR	95% CI	P-Value	OR	95% CI	P-Value
Patient characteristics									
Disease complexity (reference: Low)									
Medium	0.97	0.93 ~ 1.01	0.086	1.15	1.11 ~ 1.20	<.001	1.25	1.20 ~ 1.30	<.001
High	1.02	0.96 ~ 1.09	0.500	1.33	1.24 ~ 1.43	<.001	2.15	2.00 ~ 2.32	<.001
P4P program (reference: No)									
Yes	7.60	7.09 ~ 8.15	<.001	5.85	5.44 ~ 6.30	<.001	4.30	4.04 ~ 4.58	<.001
Number of diabetes-related visits									
	1.05	1.05 ~ 1.06	<.001	1.03	1.03 ~ 1.04	<.001	1.05	1.05 ~ 1.06	<.001
Provider characteristics									
Age (reference: 26-44 y/o)									
≧45 y/o	0.81	0.78 ~ 0.85	<.001	0.80	0.76 ~ 0.83	<.001	0.75	0.72 ~ 0.78	<.001
Sex (reference: Male)									
Female	1.31	1.22 ~ 1.41	<.001	1.35	1.24 ~ 1.46	<.001	1.25	1.15 ~ 1.34	<.001
Specialty (reference: Generalist)									
Endocrinologist	2.88	2.68 ~ 3.09	<.001	1.59	1.48 ~ 1.71	<.001	1.70	1.59 ~ 1.82	<.001
Other subspecialist	0.72	0.68 ~ 0.77	<.001	0.94	0.88 ~ 1.00	0.047	1.20	1.12 ~ 1.28	<.001

Table 4.11: Logistic regression models with GEE(s) to examine the effects of provider continuity on process indicators of quality of diabetes care: diabetes-related blood tests (continued)

Variable	Annual HbA1C Test (≧2 vs <2)			Annual Lipid Test (≧1 vs 0)			Annual Creatinine Test (≧1 vs 0)		
	OR	95% CI	P-Value	OR	95% CI	P-Value	OR	95% CI	P-Value
Organization characteristics									
Ownership (reference: Public)									
Private Non-profit	0.96	0.90 ~ 1.02	0.205	1.09	1.02 ~ 1.17	0.013	1.07	1.00 ~ 1.14	0.049
Private Profit	0.75	0.70 ~ 0.80	<.001	0.83	0.77 ~ 0.89	<.001	0.79	0.75 ~ 0.85	<.001
Accreditation level (reference: Local clinic)									
Medical center	1.86	1.70 ~ 2.04	<.001	1.49	1.36 ~ 1.64	<.001	2.60	2.37 ~ 2.84	<.001
Regional hospital	1.48	1.37 ~ 1.60	<.001	1.55	1.43 ~ 1.68	<.001	2.52	2.33 ~ 2.72	<.001
District hospital	1.62	1.51 ~ 1.73	<.001	1.45	1.36 ~ 1.56	<.001	2.21	2.07 ~ 2.36	<.001
Governing Division of NHIA (reference: Taipei Division)									
Northern Division	0.90	0.83 ~ 0.97	0.009	0.72	0.66 ~ 0.78	<.001	0.77	0.71 ~ 0.83	<.001
Central Division	0.75	0.69 ~ 0.81	<.001	0.68	0.62 ~ 0.74	<.001	0.79	0.73 ~ 0.85	<.001
Southern Division	0.84	0.78 ~ 0.91	<.001	0.76	0.70 ~ 0.83	<.001	0.81	0.75 ~ 0.87	<.001
Kao-Ping Division	0.84	0.78 ~ 0.90	<.001	0.79	0.73 ~ 0.85	<.001	0.84	0.79 ~ 0.91	<.001
Eastern Division	0.73	0.62 ~ 0.85	<.001	0.74	0.63 ~ 0.87	<.001	0.75	0.64 ~ 0.87	<.001
Year (reference: 2004)									
2005	1.14	1.10 ~ 1.19	<.001	0.98	0.94 ~ 1.02	0.257	1.06	1.01 ~ 1.11	0.012
2006	1.58	1.52 ~ 1.65	<.001	1.10	1.05 ~ 1.15	<.001	1.23	1.18 ~ 1.29	<.001
2007	2.60	2.48 ~ 2.72	<.001	1.50	1.43 ~ 1.58	<.001	1.61	1.53 ~ 1.69	<.001
2008	3.42	3.25 ~ 3.59	<.001	1.76	1.67 ~ 1.85	<.001	2.39	2.27 ~ 2.53	<.001

4.4.1.2 Adjusted Analysis

4.4.1.2.1 Provider Continuity

After controlling for all other covariates, high continuity patients had higher odds of receiving HbA1C test according to the guidelines compared with low continuity patients (OR: 1.07, 95% CI: 1.03~1.12). But high continuity patients still had lower odds of receiving annual lipid profile test (OR: 0.86, 95% CI: 0.83~0.90) and annual renal function test (OR: 0.74, 95% CI: 0.71~0.77) compared with low continuity patients.

4.4.1.2.2 Patient Characteristics

The odds of receiving HbA1C test according to the guidelines were not statistically significantly different between patients aged 45-64 years and patients aged 19-44 years (OR: 1.05, 95% CI: 0.94~1.16), but patients aged 45-64 years had higher odds of receiving annual lipid profile test (OR: 1.35, 95% CI: 1.21~1.50) and annual renal function test (OR: 1.25, 95% CI: 1.14~1.37). Diabetes patients aged 65 years and older had 21% lower odds of receiving HbA1C test according to the guidelines compared with patients aged 19-44 years (OR: 0.79, 95% CI:0.71~0.88). They had the similar odds of receiving annual lipid profile test (OR: 0.97, 95% CI: 0.87~1.08), but 32% higher odds of receiving annual real function test (OR: 1.32, 95% CI: 1.20~1.45)

compared with patients aged 19-44 years.

Female patients had similar odds of receiving HbA1C test (OR: 1.00, 95% CI: 0.95~1.05) and annual renal function test (OR: 1.04, 95% CI: 0.99~1.08) according to the guidelines compared with male patients. But female patients had 11% higher odds of receiving annual lipid profile test compared with male patients (OR: 1.11, 95% CI: 1.06~1.17).

Diabetes patients with medium income level had lower odds of receiving HbA1C test (OR: 0.93, 95% CI: 0.87~0.99) according to the guidelines, but they had similar odds of receiving annual lipid profile test (OR: 0.98, 95% CI: 0.92~1.05) and annual renal function test (OR: 1.00, 95% CI: 0.94~1.06) compared with low income patients. Diabetes patients with high income level had higher odds of receiving HbA1C test (OR: 1.12, 95% CI: 1.04~1.20) and annual lipid profile test (OR: 1.16, 95% CI: 1.08~1.25) according to the guidelines, but they had similar odds of receiving annual renal function test (OR: 1.03, 95% CI: 0.96~1.10) compared with low income patients.

Diabetes patients living in suburban areas had lower odds of receiving HbA1C test (OR: 0.82, 95% CI: 0.77~0.87), annual lipid profile test (OR: 0.82, 95% CI: 0.77~0.87) and renal function test (OR: 0.78, 95% CI: 0.73~0.82) according to the guidelines compared with those who lived in urban areas. Diabetes patients living in

rural areas also had lower odds of receiving HbA1C test (OR: 0.68, 95% CI: 0.62~0.75), annual lipid profile test (OR: 0.68, 95% CI: 0.61~0.75) and renal function test (OR: 0.62, 95% CI: 0.56~0.68) compared with those who lived in urban areas.

Diabetes patients with medium complexity had similar odds of receiving HbA1C test according to the guidelines (OR: 0.97, 95% CI: 0.93~1.01), but they had higher odds of receiving annual lipid profile test ((OR: 1.15, 95% CI: 1.11~1.20) and renal function test (OR: 1.25, 95% CI: 1.20~1.30) compared with patients with low complexity. Diabetes patients with high complexity also had similar odds of receiving HbA1C test according to the guidelines (OR: 1.02, 95% CI: 0.96~1.09), but they had higher odds of receiving annual lipid profile test (OR: 1.33, 95% CI: 1.24~1.43) and renal function test (OR: 2.15, 95% CI: 2.00~2.32) compared with patients with low complexity.

Diabetes patients who were enrolled in P4P program had much higher odds of receiving HbA1C test (OR: 7.60, 95% CI: 7.09~8.15), annual lipid profile test (OR: 5.85, 95% CI: 5.44~6.30) and renal function test (OR: 4.30, 95% CI: 4.04~4.58) according to the guidelines compared with patients who were not enrolled in P4P program.

The odds of receiving HbA1C test, annual lipid profile test and renal function test according to the guidelines was 5%, 3%, and 5% respectively increased when

diabetes patients increased one diabetes-related visit in each year (OR: 1.05, 95% CI: 1.05~1.06; OR: 1.03, 95% CI: 1.03~1.04; and OR: 1.05, 95% CI: 1.05~1.06 respectively).

4.4.1.2.3 Provider characteristics

Diabetes patients had lower odds of receiving HbA1C test (OR: 0.81, 95% CI: 0.78~0.85), annual lipid profile test (OR: 0.80, 95% CI: 0.76~0.83) and renal function test (OR: 0.75, 95% CI: 0.72~0.78) according to the guidelines if their usual provider aged 45 years and older compared with patients whose usual provider aged 44 years and less.

Diabetes patients whose usual provider was a female physician had higher odds of receiving HbA1C test (OR: 1.31, 95% CI: 1.22~1.41), annual lipid profile test (OR: 1.35, 95% CI: 1.24~1.46) and annual renal function test (OR: 1.25, 95% CI: 1.15~1.34) according to the guidelines compared with patients whose usual provider was a male physician.

Diabetes patients whose usual provider was an endocrinologist had higher odds of receiving HbA1C test (OR: 2.88, 95% CI: 2.68~3.09), annual lipid profile test (OR: 1.59, 95% CI: 1.48~1.71) and annual renal function test (OR: 1.70, 95% CI: 1.59~1.82) according to the guidelines compared with patients whose usual provider was a generalist. Diabetes patients whose usual provider was an other subspecialist

had lower odds of receiving HbA1C test (OR: 0.72, 95% CI: 0.68~0.77) and annual lipid profile test (OR: 0.94, 95% CI: 0.88~1.00), but they had higher odds of receiving annual renal function (OR: 1.20, 95% CI: 1.12~1.28) test if their usual provider was an other subspecialist compared with patients whose usual provider was a generalist.

4.4.1.2.4 Organization characteristics:

Diabetes patients who usually visited a private non-profit organization had the similar odds of receiving HbA1C test (OR: 0.96, 95% CI: 0.90~1.02) according to the guidelines, but they had higher odds of receiving annual lipid profile test (OR: 1.09, 95% CI: 1.02~1.17) and annual renal function test (OR: 1.07, 95% CI: 1.00~1.14) compared with patients who usually visited a public organization. Diabetes patients who usually visited a private profit organization had lower odds of receiving HbA1C test (OR: 0.75, 95% CI: 0.70~0.80), annual lipid profile test (OR: 0.83, 95% CI: 0.77~0.89) and annual renal function test (OR: 0.79, 95% CI: 0.75~0.85) according to the guidelines compared with those who usually visited a public organization.

Diabetes patients who usually visited a medical center, a regional hospital, or a district hospital had higher odds of receiving HbA1C test, annual lipid profile test and renal function test according to the guidelines compared patients who usually visited a local clinic. The detailed data are listed in Table 4.11.

Diabetes patients had lower odds of receiving HbA1C test, annual lipid profile test

and renal function test according to the guidelines if the organization which they usually visited was governed by Northern, Central, Southern, Kao-Ping, or Eastern Division of NHIA compared with the organization governed by Taipei Division of NHIA. All the adjusted ORs, 95% CIs and P-values are listed in Table 4.11.

4.4.1.2.5 Year

Compared with year 2004, diabetes patients had higher odds of receiving HbA1C test according to the guidelines in 2005 (OR: 1.14, 95% CI: 1.10~1.19), 2006 (OR: 1.58, 95% CI: 1.52~1.65), 2007 (OR: 2.60, 95% CI: 2.48~2.72), and 2008 (OR: 3.42, 95% CI: 3.42~3.59). Patients had similar odds of receiving annual lipid profile test in 2005 (OR: 0.98, 95% CI: 0.94~1.02), but higher odds of receiving annual lipid profile test in 2006 (OR: 1.10, 95% CI: 1.05~1.15), 2007 (OR: 1.50, 95% CI: 1.43~1.58), and 2008 (OR: 1.76, 95% CI: 1.67~1.85) compared with year 2004. Diabetes patients had higher odds of receiving annual renal function test in 2005 (OR: 1.06, 95% CI: 1.01~1.11), 2006 (OR: 1.23, 95% CI: 1.18~1.29), 2007 (OR: 1.61, 95% CI: 1.53~1.69), and 2008 (OR: 2.39, 95% CI: 2.27~2.53) compared with year 2004. The odd ratios were getting bigger over time.

4.4.2 Annual Urine Protein Test

Diabetes patients are suggested to receive urine test at least once per year to detect proteinuria or microalbuminuria. The effects of provider continuity on receiving annual urine test are showed in Table 4.12.

4.4.2.1 Unadjusted Logistic Regression

Under unadjusted analysis, diabetes patients with high continuity had 9% lower odds of receiving annual urine protein test according to the guidelines compared with patients with low continuity (OR: 0.91, 95% CI: 0.87~0.94).

4.4.2.2 Adjusted Logistic Regression

4.4.2.2.1 Provider Continuity

Under multivariate regression model, high continuity patients still had lower odds of receiving annual urine protein test compared with patients with low continuity (OR: 0.94, 95% CI: 0.90~0.99). The result was comparable to unadjusted analysis, although the odds ratio became smaller.

Table 4.12: Logistic regression models with GEE(s) to examine the effect of provider continuity on process indicators of quality of diabetes care: annual urine protein test and eye exam

Variable	Annual Urine Test (≧1 vs 0)			Annual Eye Exam (≧1 vs 0)		
	OR	95% CI	P-Value	OR	95% CI	P-Value
Unadjusted analysis						
UPC (reference: <0.75)						
≧0.75	0.91	0.87 ~ 0.94	<.001	0.94	0.91 ~ 0.98	0.001
Adjusted analysis						
UPC (reference: <0.75)						
≧0.75	0.94	0.90 ~ 0.99	0.016	1.00	0.95 ~ 1.04	0.809
Patient characteristics						
Age at baseline (reference: 19-44 y/o)						
45-64 y/o	1.05	0.93 ~ 1.18	0.474	1.03	0.93 ~ 1.14	0.539
≧65 y/o	1.06	0.94 ~ 1.20	0.352	1.13	1.02 ~ 1.26	0.019
Sex (reference: Male)						
Female	1.11	1.05 ~ 1.18	<.001	1.12	1.06 ~ 1.18	<.001
Income level (reference: Low)						
Medium	1.13	1.05 ~ 1.22	0.001	0.97	0.91 ~ 1.04	0.359
High	1.07	0.99 ~ 1.17	0.089	1.02	0.95 ~ 1.10	0.567
Residence (reference: Urban)						
Suburban	1.05	0.97 ~ 1.12	0.230	1.12	1.05 ~ 1.20	<.001
Rural	1.02	0.90 ~ 1.16	0.719	0.88	0.78 ~ 0.98	0.022
Disease complexity (reference: Low)						
Medium	1.11	1.06 ~ 1.16	<.001	1.29	1.24 ~ 1.35	<.001
High	1.24	1.15 ~ 1.34	<.001	1.77	1.65 ~ 1.90	<.001
P4P program (reference: No)						
Yes	16.65	15.70 ~ 17.65	<.001	7.80	7.41 ~ 8.21	<.001
Number of diabetes-related visits						
	1.02	1.01 ~ 1.02	<.001	1.02	1.01 ~ 1.02	<.001
Provider characteristics						
Age (reference: 26-44 y/o)						
≧45 y/o	1.00	0.95 ~ 1.05	0.994	1.04	1.00 ~ 1.09	0.062
Sex (reference: Male)						
Female	1.01	0.92 ~ 1.10	0.874	1.01	0.94 ~ 1.09	0.779
Specialty (reference: Generalist)						
Endocrinologist	1.28	1.19 ~ 1.38	<.001	1.36	1.27 ~ 1.46	<.001
Other subspecialist	0.87	0.80 ~ 0.94	<.001	0.86	0.80 ~ 0.93	<.001

Table 4.12: Logistic regression models with GEE(s) to examine the effect of provider continuity on process indicators of quality of diabetes care: annual urine protein test and eye exam (continued)

Variable	Annual Urine Test (≧1 vs 0)			Annual Eye Exam (≧1 vs 0)		
	OR	95% CI	P-Value	OR	95% CI	P-Value
Organization characteristics						
Ownership (reference: Public)						
Private Non-profit	1.78	1.66 ~ 1.92	<.001	1.16	1.08 ~ 1.23	<.001
Private Profit	0.98	0.91 ~ 1.06	0.564	0.94	0.88 ~ 1.01	0.096
Accreditation level (reference: Local clinic)						
Medical center	1.43	1.28 ~ 1.60	<.001	2.12	1.91 ~ 2.35	<.001
Regional hospital	1.14	1.04 ~ 1.25	0.005	1.39	1.28 ~ 1.52	<.001
District hospital	1.31	1.20 ~ 1.42	<.001	1.55	1.44 ~ 1.67	<.001
Governing Division of NHIA (reference: Taipei Division)						
Northern Division	1.98	1.80 ~ 2.17	<.001	1.39	1.27 ~ 1.51	<.001
Central Division	1.27	1.17 ~ 1.38	<.001	1.87	1.73 ~ 2.02	<.001
Southern Division	1.08	0.99 ~ 1.18	0.088	2.04	1.89 ~ 2.22	<.001
Kao-Ping Division	1.26	1.14 ~ 1.39	<.001	1.46	1.34 ~ 1.58	<.001
Eastern Division	0.75	0.62 ~ 0.93	0.007	1.67	1.40 ~ 1.99	<.001
Year (reference: 2004)						
2005	0.98	0.93 ~ 1.03	0.422	0.94	0.89 ~ 0.98	0.009
2006	0.92	0.87 ~ 0.97	0.004	0.90	0.86 ~ 0.95	<.001
2007	0.77	0.73 ~ 0.82	<.001	0.85	0.81 ~ 0.90	<.001
2008	0.71	0.67 ~ 0.76	<.001	0.87	0.82 ~ 0.92	<.001

4.4.2.2.2 Patient Characteristics:

Diabetes patients aged 45-64 years or ≧65 years seemed have higher odds of receiving annual urine protein test compared with those who aged 19-44 years (OR: 1.05, 95% CI: 0.93~1.18; and OR: 1.06, 95% CI: 0.94~1.20 respectively), but the differences were not statistically significant.

Female diabetes patients had 11% higher odds of receiving annual urine protein test compared with male patients (OR: 1.11, 95% CI: 1.05~1.18).

Compared with low income patients, diabetes patients with medium income level had 13% higher odds of receiving annual urine protein test (OR: 1.13, 95% CI: 1.05~1.22). High income patients seemed also have higher odds of receiving annual urine protein test, but the difference was not statistically significant (OR: 1.07, 95% CI: 0.99~1.17)

Diabetes patients living in suburban or rural areas seemed have higher odds of receiving annual urine protein test compared with those who lived in urban areas, but the differences were not statistically significant (OR: 1.05, 95% CI: 0.97~1.12; and OR: 1.02, 95% CI: 0.90~1.16 respectively).

Diabetes patients with medium or high disease complexity had higher odds of receiving annual urine protein test compared with patients with low disease complexity (OR: 1.22, 95% CI: 1.06~1.16; and OR: 1.24, 95% CI: 1.15~1.34).

Diabetes patients who were enrolled in P4P program had 16.65 times higher odds of receiving annual urine protein test compared with those who were not enrolled in P4P program (OR: 16.65, 95% CI: 15.70~17.65).

The odds of receiving annual urine protein test was 2% increased when patients increased one diabetes-related visit in each year (OR: 1.02, 95% CI: 1.01~1.02).

4.4.2.2.3 Provider Characteristics

Diabetes patients whose usual provider aged 45 years and older had similar odds of receiving annual urine protein test compared with patients whose usual provider aged 44 years and less (OR: 1.00, 95% CI: 0.95~1.05).

Diabetes patients whose usual provider was a female physician also had similar odds of receiving annual urine protein test compared with patients whose usual provider was a male physician (OR: 1.01, 95% CI: 0.92~1.10).

Compared with diabetes patients cared by generalists, patients cared by endocrinologists had higher odds of receiving annual urine protein test (OR: 1.28, 95% CI: 1.19~1.38), but patients cared by other subspecialists had lower odds of receiving annual urine protein test (OR: 0.87, 95% CI: 0.80~0.94).

4.4.2.2.4 Organization Characteristics

Diabetes patients who usually visited a private non-profit organization had 78% higher odds of receiving annual urine protein test (OR: 1.78, 95% CI: 1.66~1.92) compared with those who usually visited a public organization. However, patients usually visiting a private profit organization had similar odds of receiving annual urine protein test (OR: 0.98, 95% CI: 0.91~1.06) compared with those usually visiting a public organization.

Diabetes patients usually visiting a medical center, a regional hospital, or a district

hospital had higher odds of receiving annual urine protein test compared with patients usually visiting a local clinic (OR: 1.43, 95% CI: 1.28~1.60; OR: 1.14, 95% CI: 1.04~125; and OR: 1.31, 95% CI:1.20~1.42 respectively).

Compared with diabetes patients usually visiting a health organization governed by Taipei Division of NHIA, patients usually visiting a health organization governed by Northern, Central or Kao-Ping Division had higher odds of receiving annual urine protein test (OR: 1.98, 95% CI: 1.80~2.17; OR: 1.27, 95% CI: 1.17~1.38; and OR: 1.26, 95% CI: 1.14~1.39 respectively). Patients usually visited a health organization governed by Southern division seemed also have higher odds of receiving annual urine protein test, but the difference was not statistically significant (OR: 1.08, 95% CI; 0.99~1.18). Patients had 25% lower odds of receiving annual urine protein test if the health organization which they usually visited was governed by Eastern Division (OR: 0.75, 95% CI: 0.62~0.93).

4.4.2.2.5 Year

Diabetes patients had similar odds of receiving annual urine protein test in year 2005 (OR: 0.98, 95% CI: 0.93~1.02), but they had lower odds of receiving annual urine protein test in year 2006 (OR: 0.92, 95% CI: 0.87~0.97), 2007 (OR: 0.77, 95% CI: 0.73~0.82) and 2008 (OR: 0.71, 95% CI: 0.67~0.76) compared with2004.

4.4.3 Annual Eye Exam

According to the clinical practice guidelines, diabetes patients are suggested to receive eye exam at least once per year. The effects of provider continuity on receiving annual eye exam are also showed in Table 4.12.

4.4.3.1 Unadjusted Logistic Regression

Under unadjusted logistic regression model, diabetes high continuity patients had lower odds of receiving annual eye exam according to the guidelines compared with low continuity patients (OR: 0.94, 95% CI; 0.91~0.98).

4.4.3.2 Adjusted Logistic Regression

4.4.3.2.1 Provider Continuity

After controlling for other influences, high continuity patients had similar odds of receiving annual eye exam compared with low continuity patients (OR: 1.00, 95% CI: 0.95~1.04).

4.4.3.2.2 Patient Characteristics

Diabetes patients aged 45-64 years had similar odds of receiving annual eye exam compared with patients aged 19-44 years (OR: 1.03, 95% CI: 0.93~1.14). However, patients aged 65 years and older had higher odds of receiving annual eye exam compared with those aged 19-44 years (OR: 1.13, 95% CI: 1.02~1.26).

Female diabetes patients had higher odds of receiving annual eye exam compared

with male patients (OR: 1.12, 95% CI: 1.06~1.18).

Diabetes patients with medium or high income level had similar odds of receiving annual eye exam compared with low income patients (OR: 0.97, 95% CI: 0.91~1.04; and OR: 1.02, 95% CI: 0.95~1.10 respectively).

Diabetes patients living in suburban areas had 12% higher odds of receiving annual eye exam (OR: 1.12, 95% CI: 1.06~1.18), but patients living in rural areas had 12% lower odds of receiving annual eye exam compared with those living in urban areas (OR: 0.88, 95% CI: 0.78~0.98).

Diabetes patients with medium or high disease complexity had higher odds of receiving annual eye exam compared with patients with low disease complexity (OR: 1.29, 95% CI: 1.24~1.35; and OR: 1.77, 95% CI: 1.65~1.90 respectively).

The odds of receiving annual eye exam was 7.8 times higher for patients who were enrolled in P4P program compared with those who were not enrolled in P4P program (OR: 7.80, 95% CI: 7.41~8.21).

The odds of receiving annual eye exam was 2% increased when diabetes patients increased one diabetes-related visit in each year (OR: 1.02, 95% CI: 1.01~1.02).

4.4.3.2.3 Provider Characteristics

Diabetes patients whose usual provider aged ≧45 years seemed have higher odds of receiving annual eye exam compared with patients whose usual provider aged

26-44 years, but the difference was not statistically significant (OR: 1.04, 95% CI: 1.00~1.09).

Diabetes patients whose usual provider was a female physician had similar odds of receiving annual eye exam compared with patients whose usual provider was a male physician (OR: 1.01, 95% CI: 0.94~1.09).

Compared with those whose usual provider was a generalist, the odds of receiving annual eye exam were 36% higher if the usual provider was an endocrinologist (OR: 1.36, 95% CI: 1.27~1.46), but the odds of receiving annual eye exam were 14% lower if the usual provider was an other subspecialist (OR: 0.86, 95% CI: 0.80~0.93).

4.4.3.2.4 Organization Characteristics

Compared with diabetes patients who usually visited a public organization, patients who usually visited a private non-profit organization had 16% higher odds of receiving annual eye exam (OR: 1.16, 95% CI: 1.08~1.23). Patients who usually visited a private profit organization seemed have lower odds receiving annual eye exam, but the difference was not statistically significant (OR: 0.94, 95% CI: 0.88~1.01).

Compared with diabetes patients usually visiting a local clinic, patients usually visiting a medical center, a regional hospital, or a district hospital had higher odds of receiving annual eye exam (OR: 2.12, 95% CI: 1.91~2.35; OR: 1.39, 95% CI:

1.28~1.52; and OR: 1.55, 95% CI: 1.44~1.67 respectively).

Diabetes patients usually visiting a organization governed by Northern, Central, Southern, Kao-Ping or Eastern Division of BNHI had higher odds of receiving annual eye exam compared with patients usually visiting a organization governed by Taipei Division (OR: 1.39, 95% CI: 1.27~1.51; OR: 1.87, 95% CI: 1.73~2.02; OR: 2.04, 95% CI: 1.89~2.22; OR: 1.46, 95% CI: 1.34~1.58; and OR: 1.67, 95% CI: 1.40~1.99 respectively).

4.4.3.2.5 Year

Compared with year 2004, diabetes patients had lower odds of receiving annual eye exam according to guidelines in year 2005 (OR: 0.94, 95% CI: 0.89~0.98), 2006 (OR: 0.90, 95% CI: 0.86~0.95), 2007 (OR: 0.85, 95% CI: 0.81~0.90) and 2008 (OR: 0.87, 95% CI: 0.82~0.92).

4.5 Logistic Regression Models with Generalized Estimating Equation (GEEs) to Examine the Effects of Provider Continuity on Clinical Outcomes

The effects of provider continuity on diabetes-related emergency visit(s) and hospitalizations(s) with GEE analysis were showed in Table 4.13.

4.5.1 Diabetes-related Emergency Visit(s)

4.5.1.1 Unadjusted analysis

High continuity patients had 53% lower odds of diabetes-related emergency visit(s) compared with low continuity patients (OR: 0.47, 95% CI: 0.44~0.51).

4.5.1.2 Adjusted Analysis

4.5.1.2.1 Provider Continuity

After controlling other covariates, high continuity patients still had 45% lower odds of diabetes-related emergency visit(s) compared with low continuity patients (OR: 0.55, 95% CI: 0.51~0.60).

4.5.1.2.2 Patient Characteristics

Compared with patients aged 19-44 years, diabetes patients aged 45-64 years had 36% lower odds of diabetes-related emergency visit(s) (OR: 0.64, 95% CI: 0.53~0.78). Patients aged ≧65 years seemed also have lower odds of emergency visit(s), but the difference was not statistically significant (OR: 0.83, 95% CI: 0.69~1.01).

Table 4.13: Logistic Regression models with GEE(s) to examine the effects of provider continuity on clinical outcomes: diabetes-related emergency visit(s) and hospitalization(s)

Variable	Emergency visit(s) (≧1 vs 0)			Hospitalization(s) (≧1 vs 0)		
	OR	95% CI	P-Value	OR	95% CI	P-Value
Unadjusted analysis						
UPC (reference: <0.75)						
≧0.75	0.47	0.44 ~ 0.51	<.001	0.37	0.32 ~ 0.43	<.001
Adjusted analysis						
UPC (reference: <0.75)						
≧0.75	0.55	0.51 ~ 0.60	<.001	0.51	0.44 ~ 0.60	<.001
Patient characteristics						
Age at baseline (reference: 19-44 y/o)						
45-64 y/o	0.64	0.53 ~ 0.78	<.001	0.88	0.60 ~ 1.29	0.519
≧65 y/o	0.83	0.69 ~ 1.01	0.065	1.11	0.75 ~ 1.62	0.613
Sex (reference: Male)						
Female	1.22	1.12 ~ 1.33	<.001	1.16	0.99 ~ 1.36	0.072
Income level (reference: Low)						
Medium	0.98	0.88 ~ 1.09	0.662	0.93	0.76 ~ 1.13	0.455
High	0.76	0.67 ~ 0.86	<.001	0.80	0.64 ~ 1.00	0.049
Residence (reference: Urban)						
Suburban	1.13	1.01 ~ 1.26	0.040	1.12	0.92 ~ 1.37	0.254
Rural	1.03	0.84 ~ 1.26	0.785	1.47	1.05 ~ 2.06	0.025
Disease complexity (reference: Low)						
Medium	1.49	1.37 ~ 1.63	<.001	1.73	1.45 ~ 2.07	<.001
High	2.74	2.46 ~ 3.06	<.001	3.93	3.20 ~ 4.82	<.001
P4P program (reference: No)						
Yes	0.93	0.84 ~ 1.02	0.123	0.98	0.82 ~ 1.19	0.862
Number of Diabetes-related visits						
	1.06	1.05 ~ 1.06	<.001	1.05	1.03 ~ 1.06	<.001
Provider characteristics						
Age (reference: 26-44 y/o)						
≧45 y/o	0.89	0.82 ~ 0.97	0.005	0.82	0.70 ~ 0.96	0.015
Sex (reference: Male)						
Female	1.02	0.90 ~ 1.15	0.800	0.76	0.58 ~ 1.00	0.049
Specialty (reference: Generalist)						
Endocrinologist	1.39	1.23 ~ 1.56	<.001	0.83	0.66 ~ 1.04	0.103
Other subspecialist	1.17	1.03 ~ 1.32	0.013	0.94	0.75 ~ 1.17	0.557

Table 4.13: Logistic Regression models with GEE(s) to examine the effects of provider continuity on clinical outcomes: diabetes-related emergency visit(s) and hospitalization(s) (continued)

Variable	Emergency Visit(s) (≧1 vs 0)			Hospitalization(s) (≧1 vs 0)		
	OR	95% CI	P-Value	OR	95% CI	P-Value
Organization characteristics						
Ownership (reference: Public)						
Private Non-profit	1.09	0.97 ~ 1.21	0.136	0.88	0.71 ~ 1.09	0.250
Private Profit	1.00	0.88 ~ 1.14	0.984	1.10	0.88 ~ 1.38	0.402
Accreditation level (reference: Local clinic)						
Medical center	1.82	1.53 ~ 2.16	<.001	2.08	1.48 ~ 2.91	<.001
Regional hospital	1.79	1.54 ~ 2.08	<.001	2.27	1.70 ~ 3.03	<.001
District hospital	1.45	1.27 ~ 1.67	<.001	2.55	2.02 ~ 3.21	<.001
Governing Division of NHIA (reference: Taipei Division)						
Northern Division	1.22	1.06 ~ 1.39	0.005	1.37	1.06 ~ 1.75	0.014
Central Division	1.23	1.07 ~ 1.41	0.003	1.04	0.79 ~ 1.36	0.788
Southern Division	0.90	0.78 ~ 1.04	0.152	1.05	0.81 ~ 1.38	0.699
Kao-Ping Division	1.00	0.87 ~ 1.15	0.990	1.25	0.98 ~ 1.60	0.072
Eastern Division	1.95	1.53 ~ 2.47	<.001	1.27	0.80 ~ 2.00	0.315
Year (reference: 2004)						
2005	1.12	1.00 ~ 1.25	0.051	0.94	0.75 ~ 1.17	0.567
2006	1.12	1.00 ~ 1.26	0.060	0.97	0.77 ~ 1.21	0.760
2007	1.25	1.12 ~ 1.40	<.001	1.01	0.81 ~ 1.27	0.906
2008	1.44	1.28 ~ 1.61	<.001	1.05	0.83 ~ 1.32	0.694

Female diabetes patients had 22% higher odds of diabetes-related emergency visit(s) compared with male patients (OR: 1.22, 95% CI: 1.12~1.33).

Compared with low income patients, patients with medium income level had similar odds of diabetes-related emergency visit(s) compared with low income patients (OR: 0.98, 95% CI: 0.88~1.09); however, high income patients had 24% lower odds of diabetes-related emergency visit(s) (OR: 0.76, 95% CI: 0,67~0.86).

Diabetes patients living in suburban areas had higher odds of diabetes-related emergency visit(s) (OR: 1.13, 95% CI: 1.01~1.26); however, patients living in rural areas had similar odds of diabetes-related emergency visit(s) (OR: 1.03, 95% CI: 0.84~1.26) compared with those who lived in urban areas.

Compared with diabetes patients with low disease complexity, the odds of having diabetes-related emergency visit(s) were 1.49 times higher for patients with medium disease complexity (OR: 1.49, 95% CI: 1.37~1.63), and 2.74 times higher for patients with high disease complexity (OR: 2.74, 95% CI: 2.46~3.06).

Diabetes patients enrolled in P4P program had lower odds of diabetes-related emergency visit(s) compared with patients not enrolled in P4P program, but the difference was not statistically significant (OR: 0.93, 95% CI: 0.84~1.02).

The odds of diabetes-related emergency visit(s) were 6% higher whenever patients increased one diabetes-related OPD visit in each year (OR: 1.06, 95% CI: 1.05~1.06).

4.5.1.2.3 Provider Characteristics

Diabetes patients whose usual provider aged 45 years and older had lower odds of diabetes-related emergency visit(s) compared with diabetes patients whose usual provider aged 26-44 years (OR: 0.89, 95% CI: 0.82~0.97).

Diabetes patients whose usual provider was a female physician had similar odds of diabetes-related emergency visit(s) compared with patients whose usual provider was a male physician (OR: 1.02, 95% CI: 0.90~1.15).

Diabetes patients whose usually provider was an endocrinologist or an other subspecialist had higher odds of diabetes-related emergency visit(s) compared with patients whose usual provider was a generalist (OR: 1.39, 95% CI: 1.23~1.56; and OR: 1.17 95% CI: 1.03~1.32 respectively).

4.5.1.2.4 Organization Characteristics

Diabetes patients who usually visited a private non-profit health organization had higher odds of diabetes-related emergency visit(s) compared with those who usually visited a public health organization, but the difference was not statistically significant (OR: 1.09, 95% CI: 0.97~1.21). Patients who usually visited a private profit health organization had similar odds of diabetes-related emergency visit(s) compared with those who usually visited a public health organization (OR: 1.00, 95%: 0.88~1.14).

Diabetes patients who usually visited a medical center, a regional hospital, or a

district hospital had higher odds of diabetes-related emergency visit(s) compared with patients who usually visited a local clinic (OR: 1.82, 95% CI: 1.53~2.16; OR: 1.79, 95% CI: 1.54~2.08; and OR: 1.45, 95% CI: 1.27~1.67 respectively).

Compared with diabetes patients who usually visited a health organization governed by Taipei Division of NHIA, patients who usually visited an organization governed by Northern, Central, or Eastern Division had higher odds of diabetes-related emergency visit(s) (OR: 1.22, 95% CI: 1.06~1.39; OR: 1.23, 95% CI: 1.07~1.41; and OR: 1.95, 95% CI: 1.53~2.47 respectively). Diabetes patients who usually visited an organization governed by Southern Division seemed have lower odds of diabetes-related emergency visit(s), but the difference was not statistically significant (OR=0.90, 95% CI: 0.87~1.15). Diabetes patients who usually visited an organization governed by Kao-Ping had similar odds of diabetes-related emergency visit(s) relative to the comparison group (OR=1.00, 95% CI: 0.87~1.15).

4.5.1.2.5 Year

Compared with year 2004, diabetes patients seemed have higher odds of diabetes-related emergency visit(s) in year 2005 and 2006, but the differences were not statistically significant (OR: 1.12, 95% CI: 1.00~1.25; and OR: 1.12, 95% CI: 1.00~1.26). However, patients did have higher odds of emergency visit(s) in year 2007 and 2008 (OR: 1.25,95% CI: 1.12~1.40; and OR: 1.44, 95% CI: 1.28~1.61).

4.5.2 Diabetes-related Hospitalization(s)

4.5.2.1 Unadjusted Analysis

High continuity patients had 63% lower odds of diabetes-related hospitalization(s) compared with low continuity patients (OR: 0.37, 95% CI: 0.32~0.43).

4.5.2.2 Adjusted Analysis

4.5.2.2.1 Provider Continuity

After controlling for other covariates, high continuity patients still had 49% lower odds of diabetes-related hospitalization(s) (OR: 0.51, 95% CI: 0.44~0.60) compared with low continuity patients.

4.5.2.2.2 Patient Characteristics

Compared with diabetes patients aged 19-44 years, patients aged between 45-64 years seemed have lower odds of diabetes-related hospitalization(s), but the difference was not statistically significant (OR: 0.88, 95% CI: 0.60~1.29). Diabetes patients aged 65 years and older seemed have higher odds of diabetes-related hospitalization(s), but the difference was also not statistically significant (OR: 1.11, 95% CI: 0.75~1.62).

Female patients seemed have higher odds of diabetes-related hospitalization(s) compared with male patients, but the difference was not statistically significant (OR: 1.16, 95% CI: 0.99~1.36).

Compared with low income patients, diabetes patients with medium income level

seemed have lower odds of diabetes-related hospitalization(s), but the difference was not statistically significant (OR: 0.93, 95% CI: 0.76~1.13). However, patients with high income level did have 20% lower odds of diabetes-related hospitalization(s) compared with low income patients (OR: 0.80, 95% CI: 0.64~1.00).

Compared with patients living in urban areas, diabetes patients living in suburban area seemed have higher odds of diabetes-related hospitalization(s), but the difference was not statistically significant (OR: 1.12, 95% CI: 0.92~1.37). However, patients living in rural areas did have 47% higher odds of diabetes-related hospitalization(s) (OR: 1.47, 95% CI: 1.05~2.06).

Compared with diabetes patients with low disease complexity, the odds of diabetes-related hospitalization(s) were 1.73 times higher for patients with medium disease complexity (OR: 1.73, 95% CI: 1.45~2.07), and 3.93 times higher for patients with high disease complexity (OR: 3.93, 95% CI: 3.20~4.82).

Diabetes patients enrolled in P4P program had a little lower odds of diabetes-related hospitalization(s) compared with patients not enrolled in P4P program, but the difference was not statistically significant (OR: 0.98, 95% CI: 0.82~1.19).

The odds of hospitalization(s) due to diabetes-related complications or conditions were 5% increased whenever diabetes patients increased one diabetes- related visit in each year (OR: 1.05, 95% CI: 1.03~1.06).

4.5.2.2.3 Provider Characteristics

Diabetes patients whose usual provider aged 45 years and older had 18% lower odds of diabetes-related hospitalization(s) compared with diabetes patients whose usual provider aged 26-44 years (OR: 0.82, 95% CI: 0.70~0.96).

Diabetes patients whose usual provider was a female physician had 24% lower odds of diabetes-related hospitalization(s) compared with patients whose usual provider was a male physician (OR: 0.76, 95% CI: 0.58~1.00).

Diabetes patients whose usual provider was an endocrinologist or an other subspecialist seemed have lower odds of diabetes-related hospitalization(s) compared with patients whose usual provider was a generalist, but the differences were not statistically significant (OR: 0.83, 95% CI: 0.66~1.04; and OR: 0.94, 95% CI: 0.75~1.17 respectively).

4.5.2.2.4 Organization Characteristics

Compared with diabetes patients who usually visited a public health organization, patients who usually visited a private non-profit organization seemed have lower odds of diabetes-related hospitalization(s), but the difference was not statistically significant (OR: 0.88, 95% CI: 0.71~1.09). Patients who usually visited a private profit organization seemed have higher odds of diabetes-related hospitalization(s), but the difference was also not statistically significant (OR: 1.10, 95% CI: 0.88~1.38).

Diabetes patients usually visiting a medical center, a regional hospital, or a district

hospital had higher odds of diabetes-related hospitalization(s) compared patients usually visiting a local clinic (OR: 2.08; 95% CI: 1.48~2.91; OR: 2.27, 95% CI: 1.70~3.03; and OR: 2.55, 95% CI: 2.02~3.21 respectively).

Compared with diabetes patients usually visiting a health organization governed by Taipei Division of NHIA, patients usually visiting an organization governed by Northern Division had 37% higher odds of diabetes-related hospitalization(s) (OR: 1.37, 95% CI: 1.06~1.75). Patients usually visiting an organization governed by Central, Southern, Kao-Ping or Eastern Division of NHIA seemed also have higher odds of diabetes-related hospitalization(s) relative to the comparison group, but all the differences were not statistically significant (OR: 1.04, 95% CI: 0.79~1.36; and OR: 1.05, 95% CI: 0.81~1.38; OR: 1.25, 95% CI: 0.98~1.60; and OR: 1.27, 95% CI: 0.80~2.00 respectively).

4.5.2.2.5 Year

Compared with year 2004, diabetes patients seemed have lower odds of diabetes-related hospitalization(s) in 2005 and 2006, but higher odds of diabetes-related hospitalization(s) in 2007 and 2008. However, all the differences were not statistically significant (OR: 0.94, 95% CI: 0.75~1.17; OR: 0.97, 95% CI: 0.77~1.21; OR: 1.01, 95% CI: 0.81~1.27; and OR: 1.05, 95% CI: 0.83~1.32 respectively).

4.6 Linear Regression Models with Generalized Estimating Equation (GEEs) to Examine the Effects of Provider Continuity on Diabetes-related Healthcare Costs

The effects of provider continuity on diabetes-related healthcare costs are showed in Table 4.14. Since the data of healthcare costs were right-skewed distribution, logarithmic transformation was performed to satisfy the assumption of normal distribution. Linear regression was used for statistical analysis. We found accreditation level of the organization would be a confounding variable. So, we put the interaction term in the adjusted linear regression model.

Total healthcare costs were the sum of money which diabetes patients spent for Diabetes-related OPD visits, emergency visit(s) and hospitalization(s) in each year. Total OPD cots included the money spent on diagnosis, treatment and medications for OPD visits. Since the majority of total healthcare costs were OPD costs, and the majority of OPD costs were medication costs, we would present the effects of provider continuity on total healthcare costs, total OPD costs and OPD medication costs separately.

4.6.1 Unadjusted Linear Regression

Under unadjusted linear regression analysis, high continuity patients spent less money on diabetes-related OPD medication costs (β: -0.15, 95% CI: -0.17~-0.13); total OPD costs (β: -0.07, 95% CI: -0.08~-0.07); and total healthcare costs (β: -0.09,

Table 4.14: Linear regression models with GEE(s) to examine the effects of provider continuity on Diabetes-related healthcare costs

Dependent variable:	Ln(OPD Medication Costs)			Ln(Total OPD Costs)			Ln(Total Healthcare Costs)		
	β	95% CI	P-value	β	95% CI	P-value	β	95% CI	P-value
Unadjusted analysis									
UPC (reference: <0.75)									
≧0.75	-0.15	-0.17 ~ -0.13	<.001	-0.07	-0.08 ~ -0.07	<.001	-0.09	-0.10 ~ -0.08	<.001
Adjusted analysis									
UPC (reference: <0.75)									
≧0.75	-0.27	-0.32 ~ -0.22	<.001	-0.05	-0.06 ~ -0.04	<.001	-0.06	-0.07 ~ -0.05	<.001
Interaction terms of UPC and accreditation level									
UPC x Medical center	0.36	0.30 ~ 0.41	<.001	0.08	0.06 ~ 0.09	<.001	0.08	0.06 ~ 0.09	<.001
UPC x Regional hospital	0.41	0.36 ~ 0.47	<.001	0.13	0.11 ~ 0.14	<.001	0.12	0.10 ~ 0.14	<.001
UPC x District hospital	0.41	0.36 ~ 0.47	<.001	0.13	0.11 ~ 0.15	<.001	0.14	0.12 ~ 0.16	<.001
Patient characteristics									
Age at baseline (reference: 19-44 y/o)									
45-64 y/o	0.12	0.05 ~ 0.18	<.001	0.06	0.04 ~ 0.09	<.001	0.06	0.03 ~ 0.09	<.001
≧65 y/o	0.13	0.06 ~ 0.19	<.001	0.06	0.03 ~ 0.08	<.001	0.06	0.03 ~ 0.08	<.001
Sex (reference: Male)									
Female	0.02	-0.01 ~ 0.05	0.295	0.01	-0.00 ~ 0.03	0.052	0.01	0.00 ~ 0.03	0.033
Income level (reference: Low)									
Medium	-0.03	-0.07 ~ 0.00	0.081	-0.00	-0.02 ~ 0.01	0.693	-0.01	-0.02 ~ 0.01	0.523
High	0.01	-0.03 ~ 0.05	0.544	0.03	0.01 ~ 0.04	0.007	0.02	0.00 ~ 0.04	0.034

Table 4.14: Linear regression models with GEE(s) to examine the effects of provider continuity on diabetes-related healthcare costs (continued)

Dependent variable:	**Ln(OPD Medication Costs)**			**Ln(Total OPD Costs)**			**Ln(Total Healthcare Costs)**		
	β	**95% CI**	**P-value**	**β**	**95% CI**	**P-value**	**β**	**95% CI**	**P-value**
Residence (reference: Urban)									
Sub-urban	-0.06	-0.10 ~ -0.02	0.006	-0.03	-0.05 ~ -0.01	<.001	-0.03	-0.05 ~ -0.01	<.001
Rural	-0.15	-0.23 ~ -0.08	<.001	-0.10	-0.13 ~ -0.07	<.001	-0.10	-0.13 ~ -0.07	<.001
Disease complexity (reference: Low)									
Medium	0.05	0.04 ~ 0.07	<.001	0.01	0.01 ~ 0.02	<.001	0.03	0.02 ~ 0.03	<.001
High	0.07	0.04 ~ 0.09	<.001	0.02	0.01 ~ 0.03	0.001	0.05	0.04 ~ 0.07	<.001
P4P program (reference: No)									
Yes	-0.00	-0.03 ~ 0.02	0.882	0.17	0.16 ~ 0.18	<.001	0.17	0.16 ~ 0.18	<.001
Number of Diabetes-related visit									
	0.11	0.11 ~ 0.11	<.001	0.08	0.08 ~ 0.08	<.001	0.08	0.08 ~ 0.08	<.001
Provider characteristics									
Age (reference: 26-44 y/o)									
≧45 y/o	-0.09	-0.11 ~ -0.07	<.001	-0.05	-0.05 ~ -0.04	<.001	-0.05	-0.06 ~ -0.04	<.001
Sex (reference: Male)									
Female	0.01	-0.02 ~ 0.04	0.605	0.00	-0.01 ~ 0.02	0.512	-0.00	-0.02 ~ 0.01	0.597
Specialty (reference: Generalist)									
Endocrinologist	0.08	0.05 ~ 0.12	<.001	0.07	0.05 ~ 0.08	<.001	0.07	0.06 ~ 0.09	<.001
Other subspecialist	0.19	0.16 ~ 0.22	<.001	0.13	0.12 ~ 0.14	<.001	0.14	0.12 ~ 0.15	<.001

Table 4.14: Linear regression models with GEE(s) to examine the effects of provider continuity on diabetes-related healthcare costs (continued)

Dependent variable:	Ln(OPD Medication Costs)			Ln(Total OPD Costs)			Ln(Total Healthcare Costs)		
	β	95% CI	P-value	β	95% CI	P-value	β	95% CI	P-value
Organization characteristics									
Ownership (reference: Public)									
Private Non-profit	0.12	0.09 ~ 0.15	<.001	0.06	0.05 ~ 0.08	<.001	0.07	0.05 ~ 0.08	<.001
Private Profit	-0.04	-0.09 ~ 0.00	0.074	-0.03	-0.05 ~ -0.01	0.001	-0.02	-0.04 ~ -0.00	0.035
Accreditation level (reference: Local clinic)									
Medical center	0.49	0.43 ~ 0.55	<.001	0.26	0.24 ~ 0.29	<.001	0.28	0.25 ~ 0.31	<.001
Regional hospital	0.46	0.41 ~ 0.51	<.001	0.21	0.19 ~ 0.24	<.001	0.23	0.21 ~ 0.26	<.001
District hospital	0.37	0.32 ~ 0.41	<.001	0.17	0.15 ~ 0.19	<.001	0.18	0.16 ~ 0.20	<.001
Governing Division of NHIA (reference: Taipei Division)									
Northern Division	-0.17	-0.22 ~ -0.12	<.001	-0.11	-0.13 ~ -0.09	<.001	-0.11	-0.13 ~ -0.09	<.001
Central Division	0.06	0.01 ~ 0.11	0.012	-0.02	-0.04 ~ -0.00	0.042	-0.02	-0.04 ~ -0.00	0.042
Southern Division	-0.16	-0.21 ~ -0.12	<.001	-0.13	-0.15 ~ -0.10	<.001	-0.13	-0.15 ~ -0.10	<.001
Kao-Ping Division	-0.05	-0.09 ~ -0.01	0.020	-0.10	-0.12 ~ -0.08	<.001	-0.10	-0.12 ~ -0.08	<.001
Eastern Division	0.02	-0.09 ~ 0.12	0.713	-0.01	-0.06 ~ 0.03	0.537	-0.01	-0.06 ~ 0.03	0.537
Year (reference: 2004)									
2005	-0.06	-0.08 ~ -0.05	<.001	-0.00	-0.01 ~ 0.00	0.100	-0.00	-0.01 ~ 0.00	0.173
2006	0.00	-0.02 ~ 0.03	0.654	0.04	0.03 ~ 0.04	<.001	0.04	0.03 ~ 0.05	<.001
2007	-0.02	-0.05 ~ -0.00	0.031	0.03	0.02 ~ 0.04	<.001	0.03	0.02 ~ 0.04	<.001
2008	-0.02	-0.04 ~ 0.00	0.107	0.05	0.04 ~ 0.06	<.001	0.05	0.04 ~ 0.06	<.001

95% CI: -0.10~-0.08) compared with low continuity patients.

4.6.2 Adjusted Linear Regression

After controlling for other influences, the effects of each variable on diabetes-related healthcare costs are presented in the following.

4.6.2.1 Provider Continuity

Since we put the interaction terms in the adjusted linear regression model, the coefficient of UPC only explained the difference between high and low continuity patients cared for at local clinics, which were the reference group. The coefficient of each interaction term presented the result of difference-in-difference (DID) analysis. It took account of the extra effect of provider continuity at each different accreditation level of organization.

For diabetes patients usually cared for at local clinics, high continuity patients spent less money on diabetes-related OPD medications costs (β : -0.27, 95% CI: -0.32~-0.22); total OPD costs (β : -0.05, 95% CI: -0.06~-0.04); and total healthcare costs (β : -0.06, 95% CI: -0.07~-0.05) compared with low continuity patients. But for patients usually cared for at medical centers, high continuity patients spent more money on diabetes-related OPD medication costs (β : 0.36, 95% CI: 0.30~0.41); total OPD costs (β : 0.08, 95% CI: 0.06~0.09); and total healthcare costs (β : 0.08, 95% CI: 0.06~0.09) compared with low continuity patients, despite the negative

association between high continuity and diabetes-related healthcare costs at local clinic level. The similar results were noted among diabetes patients usually cared for at regional hospitals or district hospitals. For patients cared for at regional hospitals, high continuity patients spent more money on diabetes-related OPD medication costs (β: 0.41, 95% CI: 0.36~0.47); total OPD costs (β: 0.13, 95% CI: 0.11~0.14); and total healthcare costs (β: 0.12, 95% CI: 0.10~0.14) compared with low continuity patients, despite the negative association between high continuity and diabetes-related healthcare costs at local clinic level. For diabetes patients cared for at district hospitals, high continuity patients spent more money on diabetes-related OPD medication costs (β: 0.41, 95% CI: 0.36~0.47); total OPD costs (β: 0.13, 95% CI: 0.11~0.15); and total healthcare costs (β: 0.14, 95% CI: 0.12~0.16) compared with low continuity patients, despite the negative association between high continuity and diabetes-related healthcare costs at local clinic level.

4.6.2.2 Patient Characteristics

Diabetes patients aged 45-64 years spent more money on diabetes-related OPD medication costs (β: 0.12, 95% CI: 0.05~0.18); total OPD costs (β: 0.06, 95% CI: 0.04~0.09); and total healthcare costs (β: 0.06, 95% CI: 0.03~0.09) compared with patients aged 19-44 years. Patients aged 65 years and older also spent more money on diabetes-related OPD medication costs (β: 0.13, 95% CI: 0.06~0.19); total OPD

costs (β: 0.06, 95% CI: 0.03~0.08); and total healthcare costs (β: 0.06, 95% CI: 0.03~0.08) compared with patients aged 19-44 years.

We found the differences in diabetes-related OPD medication costs (β: 0.02, 95% CI: -0.01~0.05) and total OPD costs (β: 0.01, 95% CI: -0.00~0.03) were not statistically significant between female and male patients. But, female patients spent a little more money on total diabetes-related healthcare costs than male patients (β: 0.01, 95% CI: 0.00~0.03).

The differences in diabetes-related OPD medication costs (β: -0.03, 95% CI: -0.07~0.00), total OPD costs (β: -0.00, 95% CI: -0.02~0.01) and total healthcare costs (β: -0.01, 95% CI: -0.02~0.01) were not statistically significant between medium-income and low-income patients. High-income patients spent similar money on diabetes-related OPD medication costs (β: 0.01, 95% CI: -0.03~0.05), but more money on total OPD costs (β: 0.03, 95% CI: 0.01~0.04) and total healthcare costs (β: 0.002, 95% CI: 0.00~0.04) compared with low income patients.

Compared with diabetes patients living in urban areas, patients living in suburban areas spent less money on diabetes-related OPD medication costs (β: -0.06, 95% CI: -0.10~-0.02), total OPD costs (β: -0.03, 95% CI: -0.05~-0.01) and total healthcare costs (β: -0.03, 95% CI: -0.05~-0.01). Patients living in rural areas also spent less money on diabetes-related OPD medication costs (β: -0.15, 95% CI: -0.23~-0.08),

total OPD costs (β : -0.10, 95% CI: -0.13~-0.07) and total healthcare costs (β : -0.10, 95% CI: -0.13~-0.07).

Compared with diabetes patients with low disease complexity, patients with medium disease complexity spent more money on diabetes-related OPD medication costs (β : 0.05, 95% CI: 0.04~0.07), total OPD costs (β : 0.01, 95% CI: 0.01~0.02) and total healthcare costs (β : 0.03, 95% CI: 0.02~0.03). Diabetes patients with high disease complexity also spent more money on diabetes-related OPD medication costs (β : 0.07, 95% CI: 0.04~0.09), total OPD costs (β : 0.02, 95% CI: 0.01~0.03) and total healthcare costs (β : 0.05, 95% CI: 0.04~0.07).

Patients who were enrolled in P4P program spent similar money on diabetes-related OPD medication costs (β : -0.00, 95% CI: -0.03~0.02), but more money on total OPD costs (β : 0.17, 95% CI: 0.16~0.18) and total healthcare costs (β : 0.17, 95% CI: 0.16~0.18) compared with patients who were not enrolled in P4P program.

With the increment of diabetes-related visits, patients spent more money on diabetes-related OPD medication costs (β : 0.11, 95% CI: 0.11~0.11), total OPD costs (β : 0.08, 95% CI: 0.08~0.08) and total healthcare costs (β : 0.08, 95% CI: 0.08~0.08).

4.6.2.3 Provider Characteristics

Diabetes patients whose usual provider aged 45 years and older spent less money

on diabetes-related OPD medication costs (β : -0.0995% CI: -0.11~-0.07), total OPD costs (β : -0.05, 95% CI: -0.05~-0.04) and total healthcare costs (β : -0.05, 95% CI: -0.06~-0.04) compared with diabetes patients whose usual provider aged 26-44 years.

Diabetes patients whose usual provider was a female physician spent similar money on diabetes-related OPD medication costs (β : 0.01, 95% CI: -0.02~0.04), total OPD costs (β : 0.00, 95% CI: -0.01~0.02), and total healthcare costs (β : -0.00, 95% CI: -0.02~0.01) compared with patients whose usual provider was a male physician.

Diabetes patients whose usual provider was an endocrinologist spent more money on diabetes-related OPD medication costs (β : 0.08, 95% CI: 0.05~0.12), total OPD costs (β : 0.07, 95% CI: 0.05~0.08) and total healthcare costs (β : 0.07, 95% CI: 0.06~0.09) compared with those whose usual provider was a generalist. Diabetes patients whose usual provider was an other subspecialist also spent more money on diabetes-related OPD medication costs (β : 0.19, 95% CI: 0.16~0.22), total OPD costs (β : 0.13, 95% CI: 0.12~0.14) and total healthcare costs (β : 0.14, 95% CI: 0.12~0.15) compared with those whose usual provider was a generalist.

4.6.2.4 Organization Characteristics

Diabetes patients usually visiting a private non-profit health organization spent more money on diabetes-related OPD medication costs (β : 0.12, 95% CI: 0.09~0.15), total OPD costs (β : 0.06, 95% CI: 0.05~0.08) and total healthcare costs (β : 0.07,

95% CI: 0.05~0.08) compared with patients usually visiting a public organization. Patients usually visiting a private profit health organization spent similar money on diabetes-related OPD medication costs (β: -0.04, 95% CI: -0.09~0.00), but less money on total OPD costs (β:-0.03 95% CI: -0.05~-0.01) and total healthcare costs (β: -0.02, 95% CI: -0.04~0.00) compared with patients usually visiting a public organization.

Compared with diabetes patients who usually visited a local clinic, patients usually visiting a medical center, a regional hospital or a district hospital spent much more money on diabetes-related OPD medication costs (β: 0.49, 95% CI: 0.43~0.55; β: 0.46, 95% CI: 0.41~0.51; and β: 0.37, 95% CI: 0.32~0.41 respectively), total OPD costs (β: 0.26, 95% CI: 0.24~0.29; β: 0.21, 95% CI: 0.19~0.24; and β: 0.17, 95% CI: 0.15~0.19 respectively) and total healthcare costs (β: 0.28, 95% CI: 0.25~0.31; β: 0.23, 95% CI: 0.21~0.26; and β: 0.18, 95% CI: 0.16~0.20 respectively).

Compared with diabetes patients usually visiting a health organization governed by Taipei Division of NHIA, patients usually visiting a health organization governed by Northern, Southern, or Kao-Ping Division spent less money on diabetes-related OPD medication costs (β: -0.17, 95% CI: -0.22~-0.12; β: -0.16, 95% CI: -0.21~-0.12; and β: -0.05, 95% CI: -0.09~-0.01 respectively), total OPD costs (β: -0.11, 95% CI: -0.13~-0.09; β: -0.13, 95% CI: -0.15~-0.10; and β: -0.10, 95% CI: -0.12~-0.08

respectively) and total healthcare costs (β: -0.11, 95% CI: -0.13~-0.09; β: -0.13, 95% CI: -0.15~-0.10; and β: -0.10, 95% CI: -0.12~-0.08 respectively). Patients usually visiting an organization governed by Central Division spent more money on diabetes-related OPD medication costs (β: 0.06, 95% CI: 0.01~0.11), but a little less money on total OPD costs (β: -0.02, 95% CI: -0.04~-0.00) and total healthcare costs (β: -0.02, 95% CI: -0.04~-0.00). The differences were not statistically significant between patients usually visiting an organization governed by Eastern Division of NHIA and patients usually visiting an organization governed by Taipei Division in terms of diabetes-related OPD medication costs (β: 0.02, 95% CI: -0.09~0.12), total OPD costs (β: -0.01, 95% CI: -0.06~0.03) and total healthcare costs (β: -0.01, 95% CI: -0.06~0.03).

4.6.2.5 Year

About the time trend of diabetes-related healthcare costs, the results were not consistent. Compared with 2004, diabetes patients spent less money on diabetes-related OPD medication costs (β: -0.06, 95% CI: -0.08~-0.05), but similar money on total OPD costs (β: -0.00, 95% CI: -0.01~0.00) and total healthcare costs (β: -0.00, 95% CI: -0.01~0.00) in 2005. Patients spent similar money on diabetes-related OPD medication costs (β: 0.00, 95% CI: -0.02~0.03), but more money on total OPD costs (β: 0.04, 95% CI: 0.03~0.04) and total healthcare costs (β: 0.04, 95% CI: 0.03~0.05)

in 2006. Patients spent less money on diabetes-related OPD medication costs (β: -0.02, 95% CI: -0.05~-0.00), but more money on total OPD costs (β:0.03, 95% CI: 0.02~0.04) and total healthcare costs (β: 0.03, 95% CI: 0.02~0.04) in 2007. Patients spent similar money on diabetes-related OPD medication costs (β: -0.02, 95% CI: -0.04~0.00), but more money on total OPD costs (β:0.05, 95% CI: 0.04~0.06) and total healthcare costs (β:0.05, 95% CI: 0.04~0.06) in 2008.

Chapter 5: Discussion

5.1 The Determinants of Provider Continuity

5.1.1 Patient Characteristics and Provider Continuity

In our study, we found that old diabetes patients (i.e. aged 65 years and older), female patients, and patients with medium or high income level had higher odds of having high provider continuity. Diabetes patients living in suburban area, patients with medium or high disease complexity, and patients with more diabetes-related visits had lower odds of having high continuity. There was no significant association among middle-aged patients (i.e. aged 18-44 years), patients living in rural area, and patients enrolled in P4P program compared with the reference group.

Several studies demonstrated older patients would be more likely to see a regular doctor compared with younger patients (Jatrana, Crampton, & Richardson, 2011; Kearley et al., 2001; Overland et al., 2001; Raivio et al., 2014; Younge et al., 2012), but some studies showed different results (Cornelius, 1997; De Maeseneer et al., 2003; Goldberg & Dietrich, 1985; Knight et al., 2009; V. H. Menec et al., 2006). Our study showed old diabetes patients were more likely to see the same provider compared with young patients. But the difference did not exist between middle-aged patients and young patients. One possible reason is that old patients might have longer

relationship with their usual provider, and then resulted in higher continuity (Kearley et al., 2001). Another reason to explain why older patients had higher continuity is the limitation of transportation. Older patients are relatively vulnerable people in transportation in Taiwan. Most of them visited the healthcare organization depending on the company of their families. Therefore, they are less likely to choose different providers frequently. It might also result in high provider continuity.

Most study revealed patient sex was not associated with level of continuity (Goldberg & Dietrich, 1985; Knight et al., 2009; V. H. Menec et al., 2006; Overland et al., 2001; Schers et al., 2002; Younge et al., 2012). Some study found female patients were more likely to have low continuity (De Maeseneer et al., 2003; Knight et al., 2009). However, our study found female patients had higher odds of having high continuity compared with male patients. Like older patients, female patients are also relatively vulnerable people in transportation in Taiwan. They visited the healthcare organization usually depending on the company of their families. They had less chance to change the providers frequently. Besides, female seldom express their own opinions in Chinese culture. These reasons might be associated with high provider continuity in female patients. Our study result is consistent with the study of Nutting et al., which found female had a higher patient valued continuity of care (PVC) score than male (Nutting et al., 2003).

There were fewer studies discussed the relationship between income level and continuity of care. A study conducted in Canada for elderly people with diabetes showed that there was no significant difference in income level between high and low continuity groups (Knight et al., 2009). A study conducted in New Zealand showed low income patients had higher mean continuity of care scores because they had high health needs (Jatrana et al., 2011). But, our study found diabetes patients with medium or high level had higher odds of high continuity compared with low income patients. In Taiwan, very low income people are granted exemption from premium and co-payment when they seek health services. The exemption of co-payment might result in the doctor-shopping behaviors and then lead to low provider continuity.

Schers et al. used questionnaire to survey patients' views on continuity of care, and found residence (rural/suburban vs. city) was not associated with continuity of care (Schers et al., 2002). Our study found the odds of high continuity was not statistically significantly different between diabetes patients living in rural areas and living in urban areas, but patients living in suburban areas were more likely to have low continuity compared with urban group. The reason should be investigated further.

Comparable with other studies (Kearley et al., 2001; Knight et al., 2009), diabetes patients with medium or high disease complexity, or more diabetes-related visits were more likely to have low continuity, because they had more health needs and might

visit different doctors to solve their problems.

Although P4P program could improve care outcomes (C. C. Chen & Cheng, 2015; J. S. Cheng et al., 2015), our study showed the enrollment of P4P program was not associated with continuity of care.

5.1.2 Provider Characteristics and Provider Continuity

Our study found older providers, endocrinologists, or other subspecialists were predictors of high provider continuity; but female providers were associated with low provider continuity.

The relationship between provider characteristics and continuity of care was inconsistent in previous studies. The study of Goldberg et al. showed that physician characteristics, such as age, board certification or not, or years of current practice, were not predictive of the level of continuity (Goldberg & Dietrich, 1985). A questionnaire survey revealed younger GPs had positive attitude toward personal continuity of care in the United States (Stokes et al., 2005). A recent study conducted by Mittelstaedt et al. found longer duration in practice could improve UPC. With qualitative data from focus group interviews, they also found providers with more mature relationships with patients might achieve better interpersonal continuity (Mittelstaedt et al., 2013). Generally, older providers are more experienced in their professionalism. They usually have longer and more mature relationships with their

patients. Patients usually have more trust in older providers. It might explain why patients cared by older providers had higher provider continuity.

A questionnaire survey to examine the physicians' perception of continuity of care showed female GPs had positive attitude toward personal continuity of care in England (Stokes et al., 2005). Mittelstaedt et al. found there were no significant differences in UPC or predictors by provider sex. But, they found that patients could be concerned for maternity leave of female providers and then led to lower UPC in female providers from the qualitative analysis (Mittelstaedt et al., 2013). Our study found patients mainly cared by female providers had 9% lower odds of having high continuity compared with male providers. In Taiwan, patients usually had more trust in male providers than female providers. It could explain why patients cared by female providers had lower continuity. Leaves due to marriage, maternity of family issues could be the reason to explain why patients cared by female providers had lower continuity.

Goldberg et al. studied the continuity of care provided to primary care patients by different type of physicians and found specialty or subspecialty designation was not predictive of continuity. The UPC score was not different during family physicians, general internists and medical subspecialists (Goldberg & Dietrich, 1985). But our study found patients cared usually by a specialist or subspecialist had higher

continuity. The study of Goldberg et al. didn't target on patients with specified diseases. Our target population was diabetes patients. Diabetes patients might have more trust in the professionalism of endocrinologists and other subspecialists, especially for those who had complications or comorbidities. That's why diabetes patients cared by endocrinologists or other subspecialists were more likely to have high continuity compared with those who cared by GPs.

5.1.3 Organization Characteristics and Provider Continuity

Our study found diabetes patients usually visiting a private non-profit health organization had higher odds of having high continuity compared with those who usually visited a public health organization. Traditionally, public health organizations in Taiwan were more stereotyped and less efficient compared with private health organizations. It might result in low continuity in diabetes patients who usually visited a public organization.

In our study, diabetes patients usually visiting a medical center, a regional hospital or a district hospital were more likely to have low continuity compared with those who usually visited a local clinic. The results are comparable with previous studies. Local clinics are usually operated by sole practice or 2-3 physicians, but hospitals are operated by lots of physicians. The study of Devlin et al. showed significant negative association existed between group size and continuity. They found organizations with

more physicians experienced declines in continuity (Devlin et al., 2013). Compared with physician(s) working at local clinics, physicians working at hospitals usually not only provide OPD services to patients, but also need to do a lot of extra works, such as caring inpatients, performing specific exams, teaching young doctors, conducting researches and so on. Therefore, physicians working at hospitals could provide less OPD services in frequency and have more work-load. Mittelstaedt et al. studied provider practice characteristics that promote interpersonal continuity and found that clinic frequency was a positive predictor, but patient load was a negative predictor of continuity (Mittelstaedt et al., 2013).

Our study showed diabetes patients who usually visited an organization governed by Central Division of NHIA were more likely to have high continuity compared with those who visited an organization governed by Taipei Division, but diabetes patients were more likely to have low continuity if the organization which they usually visited was governed by Kao-Ping or Eastern Division. Taipei area is a crowded region with high density of health organizations and well-developed public transportation system. People living in Taipei area can easily approach doctors to solve their health problems, and might result in doctor-shopping behaviors. Compared with Taipei area, the public transportation is not very convenient in Central region. People living in Central region are used to visit the same provider and keep a close relationship with their usual

providers. That's why people in central area were more likely to have high continuity than people in Taipei area. Kao-Ping and Eastern Divisions of NHIA govern lots of health organizations located in remote areas. Many doctors provided services in remote areas only for short term (e.g. 1, 3, or 6 months) and then returned to cities. Due to shortage of regular medical resources, diabetes patients in Kao-Ping and Eastern areas were more likely to have low continuity.

5.2 The Effects of Provider Continuity on Quality of Diabetes Care

About the effects of provider continuity on receiving Diabetes-related tests or exams, the conclusions were not consistent. Some studies showed patients cared by a regular provider were more likely to receive diabetes-related blood tests, eye exam and foot exam (O'Connor et al., 1998; Parchman & Burge, 2002), but other studies found there was no significant association between provider continuity and completing diabetes-related tests (Gill et al., 2003; Maciejewski et al., 2013; Younge et al., 2012).

5.2.1Diabetes-related Blood Tests

5.2.1.1 Provider Continuity vs. Diabetes-related Blood Tests

Under unadjusted analysis, we found diabetes patients with high continuity had the similar odds of receiving HbA1C test according to the practice guidelines (OR: 1.01, P=0.723), but they had lower odds of receiving annual lipid profile test and renal

function test compared with low continuity patients (OR: 0.81, P<0.001; and OR: 0.72, P<0.001 respectively). After controlling for other covariates, patients with high continuity had 7% more odds of receiving HbA1C tests according to the guideless (OR: 1.07, P<0.001), but they were still had lower odds of receiving annual lipid profile test and renal function test compared with low continuity patients (OR: 0.86, P<0.001; and OR: 0.74, P<0.001 respectively) (Table 4.11). The reasons influencing diabetes patients to receive diabetes-related blood tests would be discussed in the following.

5.2.1.1.1 HbA1C test

HbA1C is a good marker to evaluate the average blood glucose levels over the previous 3 months prior to the test. Higher HbA1C level indicates poorer glucose control. Checking HbA1C periodically is important for understanding the patients' health status and modifying medications. Since the implementation of the Quality Improvement Program for Diabetes Patients (i.e. the P4P program) in 2001, most physicians were requested to attend the continuous education courses for diabetes care improvement. Therefore, physicians usually well aware of the importance of checking HbA1C regularly and would like to prescribe HbA1C testing periodically. The data of HbA1C test usually could not be read at the same time of the OPD visit. Patients should do the test before the OPD visits. It is not convenient.

Patients with high continuity typically have more close relationship with their usual providers, and more trust on them. They are more likely to follow the order when the provider prescribes the test. For patients with low continuity, they might not do the test even the provider prescribes HbA1C test. Besides, HbA1C test is a relatively costly test compared with blood glucose tests. With the limit of budget, physicians might be less likely to prescribe HbA1C test for patients with low continuity.

5.2.1.1.2 Annual Lipid Profile Test

Lipid profile is a group of blood tests (including TC, HDL, LDL and TG), to assess the risk of developing cardiovascular disease. According to the recommendations of clinical practice guidelines for diabetes patients, lipid profile test should be arranged at least once per year. To get a good-quality lipid profile test, patients are requested to be fasted for at least 8 hours. Usually, the value of lipid profile test could not be read at the same time of the OPD visit. Patients should do the test before OPD visits. It is not convenient for patients to receive the lipid profile test.

Some diabetes patients suffered from hyperlipidemia (i.e. high TC, low HDL, high LDL, or high TG), but the others not. With the limit of budget, providers might not prescribe lipid profile test yearly for those who did not suffer from hyperlipidemia to save money, although annual lipid profile test is suggested by the guidelines.

Our study found patients with high continuity were less likely to receive annual

lipid profile test than low continuity patients. High continuity patients generally had more close relationship with their providers and they were less likely to visit too many different providers. The providers of high continuity patients might think they know the patients' health status very well, and periodic lipid profile test is not necessary, especially for patients without hyperlipidemia. Therefore, the providers were less likely to prescribe lipid profile test for high continuity patients. However, patients with low continuity typically visited more different providers. The providers were less familiar with low continuity patients, and then were more likely to prescribe lipid profile test to further understand the patients' health status.

5.2.1.1.3 Annual Renal Function Test

Diabetes is a common cause of chronic kidney disease (CKD). Long-term hyperglycemia would damage kidneys and then result in CKD. The early stage of CKD could be asymptomatic. The clinical practice guidelines suggest diabetes patients should receive renal function blood test and urine protein test at least once per day to detect the early kidney damage. It is not necessary to be fasted before renal function test. Patients could get the test whenever they visit the physicians if the equipments for blood test are available at a health organization. The data of renal function test could be read 30 minutes or 1 hour after the blood is tested. Patients could know the result of renal function test at the same time when they visit their

physicians. It is a convenient test.

In Chinese culture, people regard renal function as an important indicator of health status. Some people think long-term medication would damage renal function and checking renal function frequently is necessary.

Our study found patients with high continuity were less likely to receive annual lipid profile test than low continuity patients. As we mentioned before, the usual providers of high continuity patients might not prescribe renal function test yearly for their patients because they thought they were well know the patients' health status. However, low continuity patients had more chances to get renal function test because they visited more different providers.

5.2.1.2 Patient Characteristics vs. Diabetes-related Blood Tests

5.2.1.2.1 Patient's Age

Our study found older diabetes patients had lower odds of receiving HbA1C test according to the guidelines than young patients. Older patients usually had longer disease duration. They were more aware of their health status and would like to receive conservative treatment. As we mention before, older patients might be limited in transportation. They possibly would ask their providers not to prescribe HbA1C test too frequently because it was not convenient to receive the test. In contrast with older patients, younger patients generally would like to receive intensive treatment to

prevent further complications and comorbidities. To modify medications to reach better treatment goal, checking HbA1C regularly is necessary.

In our study, middle-aged patients had 35% higher odds of receiving annual lipid profile test compared with young patients. Nutrition And Health Survey in Taiwan 2005-2008 (NAHSIT 2005-2008) showed the prevalence of hyperlipidemia was increased greatly after 45 years old, especially in terms of high TC and high LDL (NHRI, 2010). Middle-aged people were more likely to suffer from hyperlipidemia compared withyoung people. They were the main productive manpower in the families and might more highly value the good health status. Therefore, they were more likely to receive annual lipid profile test. The prevalence of hyperlipidemia in older people was also high. However, older people usually prefer conservative treatment, and they might be limited in transportation to get blood test. As a result, older diabetes patients had the similar probability to receive annual lipid profile test compared with young patients.

In terms of renal function test, both middle-aged and older patients were more likely to receive annual renal function test than young people. Compared withHbA1C test and lipid profile test, renal function test would be done easily. Patients were more likely to receive annual renal function test due to the convenience. Besides, patients might worry about the renal function decline with aging and longer disease duration,

and they would ask the providers to prescribe the test for them, especially for older patients.

5.2.1.2.2 Patient's sex

Our study found female patients had the similar probability to receive HbA1C test and annual renal function test according to the guidelines compared withmale, but they were more likely to receive annual lipid profile test than male.

NAHSIT2005-2008 showed the prevalence of hyperlipidemia was higher in female people aged≧65y/o than male (NHRI, 2010). More than 40% of our study population was people aged 65 years and older. The prevalence of hyperlipidemia could be higher in female patients compared with male patients in our study. Generally, female patients are more concerned about their own health status than male. So they were more likely to receive annual lipid profile test than male patients.

5.2.1.2.3 Income level

Diabetes patients with high income level might more highly value the good health status than low income patients, so they were more likely to receive HbA1C test according to the guidelines compared with low income patients. The phenomenon is also noted for annual lipid profile test, but not for annual renal function test.

5.2.1.2.4 Residence

Patients living in suburban or rural area were less likely to receive HbA1C test

according to the guidelines. Because there are more health organizations and well-developed public transformation system in urban area, people living in urban area are easier to get blood tests. The phenomenon is also noted for annual lipid profile test and renal function test.

5.2.1.2.5 Disease complexity

Our study found diabetes patients with medium or high disease complexity had the same probability to receive HbA1C test according to the guidelines, but were more likely to receive annual lipid profile test and renal function test than patients with low disease complexity.

HbA1C test is an essential test to monitor the effect of treatment in diabetes patients. Regardless of disease complexity, diabetes patients should receive HbA1C test periodically.

However, patients with medium or high disease complexity would be the high risk groups to develop cardiovascular diseases or CKD. The prevalence of hyperlipidemia and CKD should be higher in patients with medium or high disease complexity compared with patients with low disease complexity. Therefore, they would be more likely to receive annual lipid profile test and renal function test.

5.2.1.2.6 P4P program

Checking HbA1C test every 3 months, annual lipid profile test and annual renal

function rest are requested items in P4P program. Therefore, patients enrolled in P4P program were much more likely to receive HbA1C test, lipid profile test and renal function test according to guidelines compared with those who were not enrolled in P4P program.

5.2.1.2.7 Total number of Diabetes-related OPD visits

When patients have more diabetes-related OPD visits per year, they have more chances to receive HbA1C test. It could explain why the likelihood to receive HbA1C test≧2 per year was increased when the total number of diabetes-related OPD visit was increased. The phenomenon was also noted for annual lipid profile test and renal function test.

5.2.1.3 Provider Characteristics vs. Diabetes-related Blood Tests

5.2.1.3.1 Provider's Age

Compared with young providers, older providers were more experienced. They might well know the health status of their patients and then are less likely to prescribe HbA1C test regularly. The phenomenon was also noted for annual lipid profile test and renal function test.

5.2.1.3.2 Provider's Sex

Compared with male providers, female providers might be more attentive to their patients. Female providers might be more likely to follow the recommendations of

practice guidelines. Therefore, female patients were more likely to prescribe HbA1C test according to the guidelines than male providers. The phenomenon was also noted for annual lipid profile test and renal function test.

5.2.1.3.3 Provider's Specialty

Endocrinologists have the professional subspecialty in caring diabetes patients. The clinical practice guidelines are drew up by endocrinologists. Compared with generalists, endocrinologists are more aware of the importance of Diabetes-related tests for diabetes patients, and then they would be more likely to prescribe these tests for their patients.

In terms of other subspecialists, they might mainly focus on specific diseases related with their specialties, but not pay much attention to the patients' underlying conditions. Therefore, they might not prescribe HbA1C test for their diabetes patients according to the guidelines. The same phenomenon was also noted for annual lipid profile test. Renal function test is a cheap and convenient test. We found that other subspecialists were more likely to prescribe annual renal function test compared with generalists.

5.2.1.4 Organization Characteristics vs. Diabetes-related Blood Tests

5.2.1.4.1 Organization Ownership

Compared with diabetes patients usually cared at public health organizations,

patients cared at private non-profit health organizations were more likely to receive annual lipid profile test and renal function test. The information technology (IT) system of private non-profit health organizations might be more advanced than public health organizations. With efficient reminding system, physicians working at non-profit health organizations were more likely to prescribe annual lipid profile test and renal function test for patients, and then patients were more likely to receive these tests.

Compared with diabetes patients usually cared at public health organizations, patients cared at private profit health organizations were 25% less likely to receive HbA1C test according to the guidelines. One possible reason is that physicians working at private profit health organizations would like to save money, so they are less likely to prescribe HbA1C test because it is a costly test. Besides, the majority of private profit health organizations were local clinics. Some local clinics had limited accessibility for diabetes patients to get blood tests. The phenomenon is also noted for annual lipid profile test and renal function test.

5.2.1.4.2 Organization Accreditation Level

Physicians working at hospitals are more likely to follow the recommendations of practice guidelines. To reach the requirement of hospital accreditation, diabetes-related blood tests are set up as indicators to evaluate quality of care. The proportion

of completing diabetes-related tests or exams in diabetes patients could be an index to evaluate the performance of physicians. Therefore, diabetes patients cared by physicians working at hospitals were more likely to receive diabetes-related blood tests according to the guidelines than patients cared at local clinics.

5.2.1.4.3 Governing Division of NHIA

Compared with patients cared at health organizations governed by Taipei Division of NHIA, patients cared by other Divisions were less likely to receive Diabetes-related blood tests according to the guidelines. Because Taipei area is a crowded region with high density of health organizations and well-developed public transportation system, people living in Taipei area have more access to receive blood tests.

5.2.1.5 The Time Trends of Receiving Diabetes-related Blood Tests

Compared with year 2004, diabetes patients were more likely to receive HbA1C test according to the guidelines in 2005, 2006, 2007, and 2008. We could see the difference was becoming greater with time trend. The same phenomenon was also noted for annual renal function test.

Although diabetes patients had the similar probability to receive annual lipid profile test in 2005 compared with2004, they were more likely to receive annual lipid profile test in 2006, 2007, and 2008. The difference was also getting greater with time trend.

5.2.2 Urine Protein Test

5.2.2.1 Provider Continuity vs. Receiving Urine Protein Test

Under unadjusted analysis, we found diabetes patients with high continuity had lower odds of receiving annual urine protein test compared with low continuity patients (OR: 0.91, P<0.001). After controlling for other covariates, patients with high continuity still had lower odds of receiving annual urine protein test (OR: 0.94, P=0.016) (Table 4.12). Although urine protein test is an important test to detect early kidney damage for diabetes patients, the providers of high continuity patients might think they know the patients' health status well, and didn't prescribe the test for their patients regularly.

5.2.2.2 Patient Characteristics vs. Receiving Urine Protein Test

Both renal function blood test and urine protein test could detect early kidney damage for diabetes patients. In Taiwan, people typically more trust in blood test but not urine test. Middle-aged or older people might ask their providers to prescribe renal function blood test for them but not urine test. As a result, the odds of receiving annual urine protein test were similar among any age group.

Generally, female patients are more concerned about their own health status than male. Female patients are also more likely to suffer from urinary symptoms than male. So they were more likely to receive annual urine protein test than male patients.

Compared with low income patients, medium or high income patients should have better accessibility to receive tests. Our study found medium income patients had higher odds of receiving annual urine protein test compared with low income patients. But, the difference didn't exist between high income patients and low income patients. The reason should be investigated further,

Urine protein test could be done easily. Patients could complete the test at the same time when they visited their providers. There was no significant difference for receiving annual urine protein test among different residence.

Patients with medium or high disease complexity would have higher risk to develop CKD. Therefore, they would be more likely to receive annual urine protein test.

Like diabetes-related blood tests, diabetes patients enrolled in P4P program or with more OPD visits were also more likely to receive annual urine protein test.

5.2.2.3 Provider Characteristics vs. Receiving Urine Protein Test

Our study found provider age and provider sex were not associated with the odds of receiving annual urine protein test for diabetes patients.

Endocrinologists should be more likely to follow the recommendation of guidelines, so they were more likely to prescribe annual urine protein test for their patients and ask the patients to finish the test. Other subspecialists might not pay much attention to the patients' underlying conditions, so they were less likely to prescribe annual urine

protein test for their patients.

5.2.2.4 Organization Characteristics vs. Annual Urine Protein Test

The majority of private non-profit health organizations were hospitals. As we mentioned before, physicians working at hospitals are more likely to follow the recommendations of practice guidelines. So diabetes patients cared for at private non-profit health organizations were more likely to receive annual urine protein test compared with patients cared for at public health organizations. Urine protein test is a cheap and convenient test. Patients cared for at private profit organizations had the similar probability to receive annual urine protein test compared with patients cared for at public health organizations.

Different from diabetes-related blood tests, we found the odds of receiving annual urine protein test varied among health organizations governed by different division of NHIA. The prescribing behavior of providers could be influenced by how providers value the test and the policies of each governing division. Further study is necessary to investigate the reasons.

5.2.2.5 The Time Trends of Receiving Urine Protein Test

We found more half to 80% of diabetes patients received diabetes-related blood tests yearly, but only around 20% of diabetes patients received annual urine protein test (Table 4.6). The proportion to receive urine protein test was much lower than

diabetes-related blood tests because patients usually did not think it was an important test. The probability to receive annual urine protein test was similar between year 2004 and 2005. The probability to receive annual urine protein test was decreased in 2006, 2007, and 2008, compared with2004. The difference was getting greater with time trend.

5.2.3Diabetic Eye Exam

5.2.3.1 Provider Continuity vs. Annual Diabetic Eye Exam

Under unadjusted analysis, we found diabetes patients with high continuity had lower odds of receiving annual diabetic eye exam compared with low continuity patients (OR: 0.94, P=0.001). After controlling for other covariates, patients with high continuity had the similar odds of receiving annual diabetic eye exam (OR: 1.00, P=0.809) (Table 4.12).

For diabetes patients, regular eye exam or retinal photography is important to detect early retinopathy which could cause blindness. The health organizations should have specific equipments to provide diabetic eye exam. Some health organizations provided diabetic eye exam, but the others didn't. Due to the limited accessibility, the proportion of receiving annual diabetic eye exam was low. Our study showed around 22% of diabetes patients received annual diabetic eye exam (Table 4.6). Similar with other studies (Gill et al., 2003; Maciejewski et al., 2013), we found provider

continuity was not associated with completing annual eye exam.

5.2.3.2 Patient Characteristics vs. Diabetic Eye Exam

Older people were more likely to suffer from blurred vision than young people. When older patients suffered from blurred vision, they wound fear of getting diabetic retinopathy. Therefore, they were more likely to receive annual diabetic eye exam compared with young people.

Generally, female patients are more concerned about their own health status than male. So they were also more likely to receive annual diabetic eye exam.

Our study showed income level was not a significant factor affecting patients to receive annual diabetic eye exam.

Compared with patients living in urban areas, patients living in rural areas were less likely to receive annual diabetic eye exam because it not an easily available exam. But we found patients living in suburban areas were more likely to receive annual diabetic eye exam. The reasons should be investigated further.

Patients with medium or high disease complexity would have higher risk to develop diabetic retinopathy. Therefore, they would be more likely to receive annual diabetic eye exam.

Like diabetes-related blood tests, diabetes patients enrolled in P4P program or with more OPD visits were also more likely to receive annual diabetic eye exam.

5.2.3.3 Provider Characteristics vs. Annual Diabetic Eye Exam

Our study found provider age and provider sex were not associated with the probability to prescribe annual diabetic eye exam.

Endocrinologists were more likely to follow the recommendation of guidelines, so they were more likely to prescribe annual diabetic eye exam for their patients and ask the patients to finish the exam. Other subspecialists might not pay much attention to the patients' eye condition because it was not related to the causes of visiting the subspecialists. Therefore, they were less likely to prescribe annual diabetic eye exam for their patients.

5.2.3.4 Organization Characteristics vs. Annual Diabetic Eye Exam

The majority of private non-profit health organizations were hospitals. Physicians working at hospitals are more likely to follow the recommendations of practice guidelines. So diabetes patients cared for at private non-profit health organizations were more likely to receive annual diabetic eye exam compared with patients cared for at public health organizations..

Compared with patients cared for at health organizations governed by Taipei Division of NHIA, patients cared for by other Divisions were more likely to receive annual diabetic eye exam. The result is supervising. The value of providers and patients, the compliance of patients and the policies of governing division might

influence patients' behaviors.

5.2.3.5 The Time Trends of Receiving Annual Diabetic Eye Exam

Although diabetic eye exam is an important exam, and is recommended by clinical practice guidelines, the proportion to receive diabetic eye exam was much lower than Diabetes-related blood tests (Table 4.6). The odds of receiving annual diabetic eye exam was decreased in 2005, 2006, 2007, and 2008 compared with2004.

5.3 Diabetes-related Emergency Visits and Hospitalizations

5.3.1 Diabetes-related Emergency Visits

5.3.1.1 Provider Continuity vs. Diabetes-related Emergency Visits

Comparable with the findings of the previous studies (Cabana & Jee, 2004; S. H. Cheng et al., 2011; S. H. Cheng et al., 2011; S. H. Cheng et al., 2011; Gill & Mainous, 1998; Gill et al., 2000; Y. C. Huang et al., 2010; Ionescu-Ittu et al., 2007; W. Lin et al., 2010; V. H. Menec et al., 2005; Weiss & Blustein, 1996), our study also found patients with high continuity had lower odds of having emergency visit(s) (OR: 0.55, P<0.001) compared with low continuity patients controlling for other influences. High continuity patients generally had a close relationship with their health providers. With the ongoing relationship, the providers would be more familiar with the medical problems and health status of their patients, and then deal with the minor problem in

advance to prevent the problem became a big one. That might result in less emergency visit(s). In addition, the providers of high continuity patients might be more likely to provide disease-specific educations to their patients. The educations would enhance the abilities of self-management for diabetes patients, and then result in less emergency visit(s). High continuity patients typically had more trust in the usual provider's expertise and medical adjustment. They might visit the usual provider first when they had an urgent medical problem instead of visiting emergency room directly.

5.3.1.2 Patient Characteristics and Diabetes-related Emergency Visit(s)

We found middle-aged diabetes patients had lower odds of having emergency visit(s) compared with young age group. As we mentioned above, middle-aged patients were the main productive manpower in the families. Generally, they would be busy in working and they might have higher tolerance to physical discomfort. Middle-aged patients were less likely to ask for leave to visit emergency room unless they had a great suffering. Compared with young patients, older patients seemed to have lower odds of having emergency visit(s), but the difference was not statistically significant (OR: 0.83, P=0.065). In Taiwan, emergency visit(s) are only provided at hospitals. Older patients might have limitation in transportation that resulted in difficulty in getting emergency visit(s) at hospitals. They might prefer to visit local

clinics to solve their medical problems.

Our study showed female diabetes patients had higher odds of emergency visit(s) than male patients. The possible explanation might be that female are more sensitive and have lower tolerance to physical discomfort.

We found diabetes patients with high income level had lower odds of emergency visit(s) than low income patients. The same finding had been noted in the previous studies (Booth & Hux, 2003; S. H. Cheng et al., 2011; Ionescu-Ittu et al., 2007). As we mentioned before, high income patients might more highly value the good health status. Generally, high income patients are more likely to visit their usual provider routinely and have better compliance with the provider's orders. Most of their medical problems could be solved in routine OPD visiting. Therefore, they visited emergency rooms less frequently. For low income patients, the exemption of NHI co-payment could be a reason to explain why they visited emergency room more frequently.

(Ionescu-Ittu et al., 2007)(Ionescu-Ittu et al., 2007)Ionescu-Ittu et al. found elderly people living in suburban or rural areas were more likely to have emergency visit(s) compared with those living in urban areas *(Ionescu-Ittu et al., 2007)*. Our study also showed suburban diabetes patients had higher odds of having emergency visit(s) compared with urban patients. In Taiwan, patients living in suburban areas have relatively limited medical resources than patients living in urban areas. The medical

problems of suburban patients might not be treated well in OPD visits. Therefore, suburban patients were more likely to have emergency visit(s) than urban patients. However, the phenomenon was not noted for rural patients in our study. We think rural patients also have medical needs for emergency services. But emergency services are less available in rural areas of Taiwan. So our study found rural patients had the similar odds of having emergency visit(s) compared with urban patients.

Comparable with other studies (S. H. Cheng et al., 2011; Ionescu-Ittu et al., 2007), patients with medium or high disease complexity had higher odds of having emergency visit(s) compared with patients with low complexity. The odds ratio was bigger for patients with high complexity.

Our study found diabetes patients enrolled in P4P program seemed to have lower odds of emergency visit(s) compared with patients not enrolled in P4P program, but the difference was not statistically significant (OR: 0.93, P=0.123). Typically, diabetes patients enrolled in P4P program got intensive care to achieve the treatment goal and were less likely to visit emergency rooms due to diabetes-related complications. However, intensive care might increase the probability of hypoglycemic episodes, and then result in increased emergency visit(s). Therefore, we saw the difference of diabetes-related emergency visit(s) was not significant between patients enrolled and not enrolled in P4P program.

Increased total number of diabetes-related OPD visits might mean increased medical needs for diabetes patients. Therefore, we found the odds of diabetes-related emergency visit(s) were increased with the increasing of total number of Diabetes-related visits.

5.3.1.3 Provider Characteristics and Diabetes-related Emergency Visit(s)

Compared with young providers, older providers were more experienced. Therefore, patients cared by older providers had lower odds of having diabetes-related emergency visit(s) than patients cared with young providers.

We found provider sex was not associated with diabetes-related emergency visit(s).

Patients cared by endocrinologists or other subspecialists had higher odds of emergency visit(s) than patients cared by generalists. One possible explanation could be patients cared by endocrinologists or other subspecialists were more likely to have hypoglycemic episodes because they usually receive intensive care to prevent further complications.

5.3.1.4 Organization Characteristics and Diabetes-related Emergency Visit(s)

We found the organization ownership was not associated with diabetes-related emergency visit(s).

Typically, emergency services were available at hospitals but not at local clinics. We found patients usually cared for at hospitals were more likely to seek emergency

services than patients cared at local clinics. The magnitude of difference was the most significant between medical centers and local clinics.

Our study found patients cared for by the organizations governed by Northern, Central, or Eastern Division of NHIA had higher odds of diabetes-related emergency visit(s) compared with patients cared by Taipei Division. As we mentioned above, Taipei area is a crowded region with high density of health organizations and well-developed public transportation. Patients living in Taipei area are more easily to get medical treatment. With the easy access, most medical problems could be managed at OPD services. Therefore, patients living in Taipei area were less likely to visit emergency room.

5.3.1.5 The Time Trends of Diabetes-related Emergency Visit(s)

Compared with year 2004, diabetes patients had more emergency visit(s) in year 2005, 2006, 2007, and 2008. Although the odds ratio was not statistically significant in year 2005 and 2006, it was statistically significant in year 2007 and 2008, and getting bigger over time. We need more data in the following years to see if the trend persists over time. The policy makers need to pay attention to the trend, and try to figure out the reasons resulting in increased emergency visit(s).

5.3.2 Diabetes-related Hospitalization(s)

5.3.2.1 Provider Continuity vs. Diabetes-related Hospitalization(s)

Our study found diabetes patients with high continuity had lower odds of hospitalization(s) (OR: 0.51, P<0.001) compared with low continuity patients after controlling for other influences. High continuity results in a close relationship between patients and health providers. With the close relationship, the providers would be more familiar with the medical problems and health status of their patients, and then deal with the minor problem in advance to prevent the problem became a big one. And then hospitalization(s) could be avoided. The result was comparable with the findings of several previous studies (Cabana & Jee, 2004; S. H. Cheng et al., 2010; S. H. Cheng et al., 2011; S. H. Cheng et al., 2011; S. H. Cheng et al., 2011; S. H. Cheng et al., 2011; Gill & Mainous, 1998; Gill et al., 2000; Y. C. Huang et al., 2010; Ionescu-Ittu et al., 2007; Knight et al., 2009; W. Lin et al., 2010; W. Lin et al., 2010; V. H. Menec et al., 2005; V. H. Menec et al., 2006; Weiss & Blustein, 1996),

5.3.2.2 Patient Characteristics and Diabetes-related Hospitalization(s)

Our study found the patient's age and sex was not associated with Diabetes-related hospitalization(s).

We found diabetes patients with high income level had lower odds of hospitalization(s) than low income patients. The same finding had been noted in

previous studies (Booth & Hux, 2003; Booth & Hux, 2003; S. H. Cheng et al., 2010; S. H. Cheng et al., 2011; Ionescu-Ittu et al., 2007; Knight et al., 2009). High income patients might more highly value the good health status and have more resources to keep good health status. Generally, they are more likely to visit their usual provider routinely and have better compliance with the provider's orders. These reasons might explain the lower hospitalization rate in high income patients.

Diabetes patients living in rural areas could not get adequate medical resources to manage their medical problems at routine OPD services. Therefore, they had higher odds of diabetes-related hospitalization(s) compared with patients living in urban areas. The result was comparable with Cheng's study which showed low physician density was positively associated with hospital admissions (Booth & Hux, 2003; S. H. Cheng et al., 2011).(Ionescu-Ittu et al., 2007)(Ionescu-Ittu et al., 2007)

Comparable with the previous studies (Booth & Hux, 2003; S. H. Cheng et al., 2010; S. H. Cheng et al., 2011; Ionescu-Ittu et al., 2007; Knight et al., 2009; V. H. Menec et al., 2006), patients with medium or high disease complexity had higher odds of hospitalization(s) compared with patients with low complexity. The difference was especially more significant for patients with high complexity.

The conclusion of the effect of P4P program on diabetes patients is incoherent. Chien et al. found P4P program didn't reduce hospitalization for diabetes (Chien,

Eastman, Li, & Rosenthal, 2012). Chen et al. found diabetes patients were less likely to be hospitalized if they saw P4P-participating physicians for long-term (i.e. three consecutive years). But the effect was not significant if patients saw P4P-participating physicians for short-term (i.e. 1 year) (J. Y. Chen et al., 2010). Two studies in Taiwan showed patients enrolled in P4P program had fewer Diabetes-related hospitalizations compared to those who did not (C. C. Chen & Cheng, 2015; Lee et al., 2010). Our study found enrollment in P4P program was not associated with Diabetes-related hospitalization(s) (OR: 0.98, P=0.862). More evidence is needed to evaluate the effect of P4P program on Diabetes-related hospitalizations for diabetes patients.

Increased total number of diabetes-related OPD visits might mean increased medical needs for diabetes patients. Therefore, we found the odds of diabetes-related hospitalization(s) were increased with the increasing of total number of diabetes-related visits. The similar results were noted in several studies (Booth & Hux, 2003; S. H. Cheng et al., 2010; S. H. Cheng et al., 2011; W. Lin et al., 2010).

5.3.2.3 Provider Characteristics and Diabetes-related Hospitalization(s)

Compared with young providers, older providers were more experienced. Therefore, patients cared for by older providers had lower odds of diabetes-related hospitalization(s) than patients cared with young providers.

Compared with male providers, female providers typically are more careful to treat

their patients. Our study showed patients cared by female providers had higher odds of having Diabetes-related blood tests (Table 4.11), and therefore got better quality of care. These reasons might explain why patients cared by female providers had lower odds of diabetes-related hospitalization(s).

Patients cared for by endocrinologists or other subspecialists had lower odds of hospitalization(s) than patients cared by generalists, but the difference was not statistically significant. Diabetes patients cared for by endocrinologists or other subspecialists were more likely to get incentive care to reach treatment goal. Generally, they might have better outcomes compared with patients cared by generalists. But the intensive care might result in some complications, such as hypoglycemic episodes, which lead to hospitalization(s).

5.3.2.4 Organization characteristics and Diabetes-related Hospitalization(s)

After controlling for other covariates, we found the organization ownership was not significantly associated with Diabetes-related hospitalization(s).

Patients usually cared for at hospitals had higher odds of receiving diabetes-related blood tests, urine test and eye exam compared with patients cared at local clinics (Table 4.11 & 4.12). They were more likely to be hospitalized for further evaluation and treatment if abnormal consequences or complications related to diseases were detected via blood/urine tests or some specific exams. Therefore, patients cared for at

hospitals had higher odds of hospitalizations compared with those cared for at local clinics. Patients cared for at district hospitals had the highest odds of hospitalization(s). The possible reason might be the indications for admission were relatively loose at district hospitals compared with medical centers or regional hospitals. The similar result had been found in Chen's study (C. C. Chen & Cheng, 2015).

To provide more efficient services to enrollee, the NHIA in Taiwan has six regional divisions that handle premium collections, utilization review and reimbursements, and the management of contracted healthcare organizations at local level. Each NHIA division has individual budget, and might have different policies or criteria for utilization reimbursements. Except medical resources and medical needs, the policies of reimbursement might influence the providers' prescription behaviors. The Northern Division of NHIA might set relatively loose criteria for hospitalization compared with Taipei Division. Therefore, patients cared at the organization governed by Northern Division were more easily to be hospitalized if they had the needs. Patients living in Kao-Ping or Eastern areas might also have medical needs for hospitalizations. But there were relatively fewer hospitals in Kao-Ping or Eastern areas. They got fewer opportunities to be hospitalized. We need to check more detailed claims data to get more evidences.

5.3.2.5 The Time Trends of Diabetes-related Hospitalization(s)

Our study found the time trends of diabetes-related hospitalization(s) were not significant after controlling for other influences.

5.4 Diabetes-related Healthcare Costs

5.4.1 Provider Continuity vs. Diabetes-related Healthcare Costs

The previous studies revealed that low continuity of care was associated with higher health expenditures (Cornelius, 1997; Raddish et al., 1999), and high provider continuity was associated with lower healthcare costs (De Maeseneer et al., 2003; Hollander & Kadlec, 2015). These studies were done within a family-doctor-based healthcare system. The healthcare system in Taiwan is characterized by universal health insurance coverage and unrestricted physician choices. Patients can go any different level of healthcare organizations (i.e. local clinic, district hospital, regional hospital, or medical center) to seek healthcare services if they pay the required co-payment. The features of Taiwan's healthcare system may result in patients' doctor-shopping behaviors and then increase healthcare costs. Two recent studies conducted in Taiwan showed high continuity of care reduced pharmaceutical, OPD and total healthcare costs in diabetes patients (C. C. Chen & Chen, 2011; J. S. Cheng et al., 2015). Our study found the effects of provider continuity on diabetes-related

healthcare costs varied depending on accreditation level of healthcare organizations. For patients usually cared for at local clinics, high continuity patients spent less money on diabetes-related healthcare costs compared with low continuity patients, especially on OPD medications costs. However, for patients usually cared at medical centers, regional hospitals or district hospitals, high continuity patients spent more money on diabetes-related healthcare costs compared with low continuity patients. The differences were more extensive in terms of OPD medication costs. According to our findings, patients cared at local clinics had lower odds of receiving diabetes-related tests and exams compared with patients cared at hospitals (Table 4.11 & 4.12). The providers of local clinics might seldom regulate the patients' medication prescriptions if the patients didn't complain of physical sufferings. Patients treated at local clinics with low continuity were those who might visit several different providers and have multiple somatic complaints. Polypharmacy and medication duplication could be noted in the kind of patients. Therefore, higher OPD medication costs were noted in low continuity patients at local clinic level. Patients cared for at hospitals had higher odds of receiving diabetes-related tests and exams. The providers might prescribe more high-potency medications for high continuity patients to reach the treatment goals according to the results of tests and exam. Besides, new and more expensive medications were usually available at hospitals, but seldom at local clinics.

The providers were more likely to prescribe new and expensive medications for the patients with a close and trust relationship. Therefore, patients cared for at hospitals with high continuity spent more money compared with low continuity patients. However, high continuity patients had less OPD visits, emergency visits and hospitalizations compared with low continuity patients. The differences between high and low continuity patients in total OPD costs and total healthcare costs were smaller relative to OPD medication costs.

5.4.2 Patient Characteristics vs. Diabetes-related Healthcare Costs

We found middle-aged and old diabetes patients both spent more money on OPD medication costs, total OPD costs and total healthcare costs compared with young patients. The similar results could be found in Chen's study (C. C. Chen & Chen, 2011). With aging, diabetes patients are more likely to suffer from physical and mental discomforts. To solve the problems, they might have more OPD visits, take more medications, and receive more tests and exams. These might explain the higher healthcare costs in middle-aged and old patients.

We found female patients spent the similar money on diabetes-related OPD medications and total OPD costs, but more money on total healthcare costs compared with male. The higher odds of diabetes-related emergency visit(s) in female patients might contribute to the higher total healthcare costs (Table 4.13).

According to our findings, high-income patients had higher odds of receiving diabetes-related blood tests compared with low income patients (Table 4.11). It might explain high-income patients had higher total OPD costs than low-income patients. Although high-income patients had lower odds of emergency visit(s) and hospitalization(s) which resulted in reduced total healthcare costs, they still had higher total healthcare costs compared with low-income patients because costs of emergency visit(s) and hospitalization(s) were only a small proportion of total healthcare costs.

Patients living in suburban or rural areas had relatively limited medical sources and had lower odds of receiving diabetes-related blood tests compared with patients living in urban areas. Therefore, they had lower OPD medication costs, total OPD costs and total healthcare costs.

Patients with medium or high disease complexity had more medical needs compared with low disease complexity patients. Therefore, they had higher OPD medication costs, total OPD costs and total healthcare costs.

We found patients enrolled in P4P program spent the similar money on OPD medication costs compared with those who were not enrolled in P4P program, but had higher total OPD costs and total healthcare costs because they had much higher odds of receiving diabetes-related tests and exams.

The more OPD visits, the more medical needs. The OPD medication costs, total

OPD costs and total healthcare costs were increased when diabetes patients had more OPD visits.

5.4.3 Provider Characteristics vs. Diabetes-related Healthcare Costs

Senior providers usually were more experienced and less likely to prescribe unnecessary medications or tests to their patients compared with young providers. Therefore, patients cared by senior providers had lower OPD medication costs, total OPD costs and total healthcare costs compared with patients cared by young providers.

Even patients cared for by female providers had higher odds of receiving diabetes-related blood tests and lower odds of hospitalization(s) compared with patients cared for by male providers; the differences in OPD medication costs, total OPD costs and total healthcare costs were not statistically significant between the two groups.

Generally, subspecialists (including endocrinologists) were more likely to offer intensive care to their patients. They might prescribe new or more expensive medications to reach the treatment goals. Some specific medications only could be prescribed by subspecialists. Therefore, patients cared for by subspecialists had higher OPD medication costs, total OPD costs and total healthcare costs compared with patients cared for by generalists.

5.4.4 Organization Characteristics vs. Diabetes-related Healthcare Costs

As we mentioned before, public health organizations in Taiwan were more stereotyped and less efficient compared with private health organizations. Typically, private health organizations were more likely to provide customer-oriented services. Therefore, patients cared at private health organizations should had higher diabetes-related healthcare costs compared with patients cared at public health organizations. Private health organizations included private non-profit and private profit organizations. In our study, most (98%) of private non-profit organizations were hospitals, and 61% of private profit organizations were local clinics (Appendix 4). New medications, expensive medications, laboratory tests and Diabetes-related exams were more easily available at hospitals than local clinics. Physicians working at hospitals were more likely to arrange diabetes-related tests and exams for their patients to evaluate their health status, and were also more likely to prescribe new or expensive medications to reach treatment goal. Consequently, patients cared at private non-profit organizations had higher OPD medication costs, total OPD costs and total healthcare costs than patients cared at public organizations. On the contrary, physicians working at local clinics were less likely to arrange Diabetes-related tests and exams and also less frequently to regulate the medications for their patients. As a result, patients cared at private profit organizations had the similar OPD medication

costs, but lower total OPD costs and lower total healthcare costs compared with patients cared at public organizations.

5.4.5 The Time Trends of Diabetes-related Healthcare Costs

Compared with year 2004, diabetes patients had lower or the similar OPD medication costs in year 2005, 2006, 2007, and 2008. One possible reason could be NHIA cut down the reimbursements for medications yearly. Over time, the disease might be progressing. Physicians were more likely to arrange laboratory tests or other exams more frequently when the disease is progressing. Therefore, we can see diabetes patients had higher total OPD costs and total healthcare costs in year 2006, 2007 and 2008 compared with year 2004.

5.5 Policy Implications

The results of our study present some important implications for the establishment of healthcare policies.

First, we found high provider continuity was significantly associated with reduced diabetes-related emergency visit(s) and hospitalization(s) (Table 4.13). Accordingly, improving provider continuity should be beneficial for diabetes patients. Our study revealed diabetes patients with high or medium income had higher odds of high continuity (Table 4.10). In other words, low income patients were more likely to have low continuity. The results were different from two international studies (Knight et al.,

2009). It might be related to the exemption of co-payment for very low income patients in Taiwan. Originally, the policy was established to take good care of the poor. However, it might result in medical resource overuse and doctor-shopping behaviors. Therefore, health policy makers should consider modifying the policy for the patients with high healthcare utilization to avoid excessive healthcare consumption.

From this study, we also found patients usually visiting the Kao-Ping or Eastern health organization had significantly lower odds of high continuity compared with patients usually visiting the Taipei health organization (Table 4.10). Kao-Ping and Eastern Divisions of NHIA govern lots of health organizations located in remote areas. Many doctors provided services in remote areas only for short term (e.g. 1, 3, or 6 months) and then returned to the cities. Shortages of regular medical resources could be a reason leading to lower continuity in remote areas of Taiwan. The inequity of access to medical care resulted in worse health outcomes (Table 4.13). Health policy maker should pay more attention to this issue and try to provide regular medical sources to people living in remote areas.

Our study revealed the proportion of diabetes patients receiving diabetes-related blood tests increased over time. In 2005, more than 80% of patients received diabetes-related blood tests according to the recommendations of guidelines. However, the proportion of patients receiving diabetes-related urine test and eye exam was low.

Only around one-fifth of diabetes patients received annual urine test and eye exam in each year. High continuity patients had higher odds of receiving HbA1C tests, but lower odds of receiving annual lipid profile test, renal function test and urine test. It is well known that diabetes-related tests and exams would help the health providers to detect the medical problems at an early stage for the patients to prevent the following complications. Except the payment of fee for services, health policy makers could consider providing extra incentive payment to encourage the health providers prescribing the diabetes-related tests and exams according to guidelines.

As we mentioned above, high provider continuity was significantly associated with reduced diabetes-related emergency visit(s) and hospitalization(s) (Table 4.13). Patients cared for at local clinics had higher odds of high continuity compared with patients cared for at hospitals (Table 4.10). After controlling for the influences of provider continuity and other covariates, patients cared for at local clinics still had lower odds of diabetes-related emergency visit(s) and hospitalization(s) compared with patients cared for at hospitals (Table 4.13). All the evidences suggested that patients cared for at local clinics had better clinical outcomes compared with patients cared for at hospitals. The healthcare system in Taiwan is well known for its unrestricted physician choice. Many patients were used to going to hospitals for primary care. Patients cared for at hospitals might get more new and expensive

medications, and receive more tests and exams, but not have superior outcomes. In terms of healthcare costs, we also found patients cared for at local clinics with high continuity had lower healthcare costs compared with low continuity patients; but the effects were not noted for patients cared for at hospitals (Table 4.14). Diabetes is a prevalent chronic disease and an ambulatory sensitive condition. Most diabetes-related medical problems can be managed at the local clinic setting. Unrestricted health-seeking behaviors might result in more medical resource consumption and increased healthcare costs. Therefore, health policy makers should seriously consider how to implement a system in which family physicians serve as gatekeepers for referrals to provide effective care for diabetes patients and avoid medical resource overuse.

5.6 Strengths and Weaknesses

5.6.1 Strengths

Compared with the previous studies, which usually took patient characteristics into account but considered of provider or organization characteristics less, our study is a more comprehensive one. Since this study has a large sample size, more independent variables were included for analysis. Except patient characteristics, we also take provider and organization characteristics into consideration. The results of our study help us understand the factors influencing provider continuity and the association

between provider continuity and outcome measures in detail.

Because we used a sub-dataset (LHID 2005) randomly sampled from the national claims data (NHIRD) to conduct the study, the external generalizability for adult diabetes patients in Taiwan should be good. In addition, the claims data could actually reflect the patients' health seeking behaviors and the physicians' prescribing behaviors, and demonstrate strong population-based evidences.

Most of the previous studies examining the effects of continuity of care were done with a cross-sectional design. However, we used a longitudinal design to conduct the study. The cross-sectional design can only provide information at one given point in time; it can not show the changes of patients' health-seeking behaviors over time. Compared with a cross-sectional study design, a longitudinal design demonstrates the time trend in continuity of care. Moreover, longitudinal data analysis accounts for variation among individuals and unobserved time-invariant characteristics of patients. The longitudinal study design strengthens the inference of our study.

5.6.2 Weaknesses

Our study excluded the diabetes patients who died during 2004 to 2008 because we could not bet the mortality data from NHIRD, and we hope to observe the whole study population within the same period. The diabetes patients who died during the

study period might be those who had lower provider continuity, more emergency visits, more hospitalizations, and/or higher healthcare costs. Excluding these patients might result in underestimation of the effects of provider continuity.

Since we used secondary dataset to conduct the study, omitted variables bias is difficult to avoid. Some patient characteristics (e.g. educational level, marital status, duration of diabetes), and provider characteristics (i.e. duration in practice, clinical frequency, patient load) which might influence both provider continuity and outcome measures were not included in our study.

We categorized income level of patients according to the household income presented to NHIA to calculate premiums. The data might not actually reflect the income level of patients and result in information bias. We also could not exactly detect the residence of patients. We categorized the residence of patients according to the area where the health organizations which the patients visited the most frequently were located. It could also result in information bias.

We evaluate quality of care with process indicators but not outcome indicators because we could not link the claims data to individual medical records. Intermediate outcomes of individuals, such as HbA1C level and lipid profile level, were not available in our study. However, the outcome indicators would be more meaningful for quality of care evaluation than process indicators.

Because we used the NHIA claims data to conduct the study, self-paid costs were not included in our study. It might result in underestimation of diabetes-related healthcare costs. Since NHI covered most costs of medications, tests and exams, we assume the self-paid costs would be minimal.

One unique feature of the healthcare system in Taiwan is free of physician choice without formal referral arrangements. Therefore, the findings of our study could be generalizable to countries without a referral system but not to countries with a referral system, such as Canada and the United States.

5.7 Future Study Plans

Our study found some patient, provider and organization characteristics were associated with low provider continuity. To further investigate the causes resulting in low provider continuity, qualitative researches are necessary. For patients with low provider continuity, such as low-income patients, patients with medium or high disease complexity, patients cared for by young providers, patients cared for by female providers, patients cared for by generalists, patients usually treated at hospitals and patients living in Kao-Ping or Eastern area, we need to conduct questionnaire surveys to understand the patients' concerns and the obstacles leading to low continuity. Then, we could develop strategies to improve low provider continuity.

Our study is only a 5-year observational cohort study. The effects of continuity of

care might vary if given more time. Longer observation period would provide more information and help us understand the trends of the patients' and physicians' behaviors further. Once the new datasets are available, we plan to extend our study to a longer observation period to get more evidences and make more precise conclusions.

Except provider continuity, we are also interested in site continuity. With the advancement of medical information system, the provider's prescribing behaviors and patient's health-seeking behaviors are changing. With a well-developed reminding system and good information continuity, the patients could still get continuous care at the same health organization even they receive health services from different providers. Consequently, site continuity might be a better predictor than provider continuity to evaluate the effects of continuity of care.

We assumed that high continuity patients should have lower healthcare costs. However, our study revealed different results according to different accreditation level of organizations. For patients usually treated at local clinics, high continuity patients did have lower healthcare costs; but for patients usually treated at hospitals, high continuity patients had higher healthcare costs. Therefore, we plan to conduct subgroup analysis and questionnaire surveys to find out the differences between local clinics and hospitals.

One weakness of our study is that the data of laboratory tests and exams were not available because the claims data could not link to individual medical records. With the development of electronic technology, the NHIA built the “NHI Pharma Cloud System” in July 2013 and the “My Health Bank System” in October 2014. In the future, individual laboratory data might be available via internet, cloud system or other information technologies. Then we can use the data for analysis to further understand the effects of continuity of care on quality of diabetes-care.

Chapter 6 Summary and Conclusions

Our study revealed diabetes patients aged ≧65 years, female patients, medium or high income patients, patients cared by the provider aged≧45 years, patients cared by an endocrinologist or a other subspecialist, patients usually visiting a private non-profit organization and usually visiting the Central health organization had higher odds of high continuity relative to comparisons after controlling for other influences. Patients living in sub-urban areas, with medium or high disease complexity, with more diabetes-related visits, cared for by a female provider, usually visiting a medical center, a regional hospital, or a district hospital, usually visiting the Kao-Ping or Eastern health organization had lower odds of high continuity relative to comparisons after controlling for other influences.

In terms of diabetes-related tests and exams, high continuity patients had higher odds of receiving HbA1C test at least twice per year, but had lower odds of receiving annual lipid-profile test, renal function test, and urine protein test according to the recommendations of diabetes guidelines compared with low continuity patients. The odds of receiving annual eye exam were not statistically significantly different between high and low continuity patients.

We found high continuity patients still significantly had lower odds of diabetes-related emergency visit(s), and diabetes-related hospitalization(s) compared with low

continuity patients after controlling for all other covariates. Except provider continuity, accreditation level of health organization could be another important factor to influence the clinical outcomes. We also found patients cared for at hospitals (including medical centers, regional hospitals, and district hospitals) had higher odds of diabetes-related emergency visit(s), and hospitalization(s) compared with patients cared for at local clinics. It suggested that patients cared for at local clinics had better clinical outcomes compared with patients cared for at hospitals.

In terms of healthcare costs, we found the effects of provider continuity were different according to different accreditation level of health organizations. For diabetes patients usually cared for at local clinics, we found high continuity patients spent less money on diabetes-related OPD medication costs, total OPD costs and total healthcare costs. But for patients usually cared for at medical centers, regional hospitals, or district hospitals, we found high continuity patients spent more money on diabetes-related OPD medication costs; total outpatient costs; and total healthcare costs compared with low continuity patients, despite the negative association between high continuity and diabetes-related healthcare costs at local clinic level.

With the study, we found the factors affecting provider continuity, diabetes-related quality of care, clinical outcomes and healthcare costs. Although high provider continuity didn't improve the diabetes patients' behaviors to receive diabetes-specific

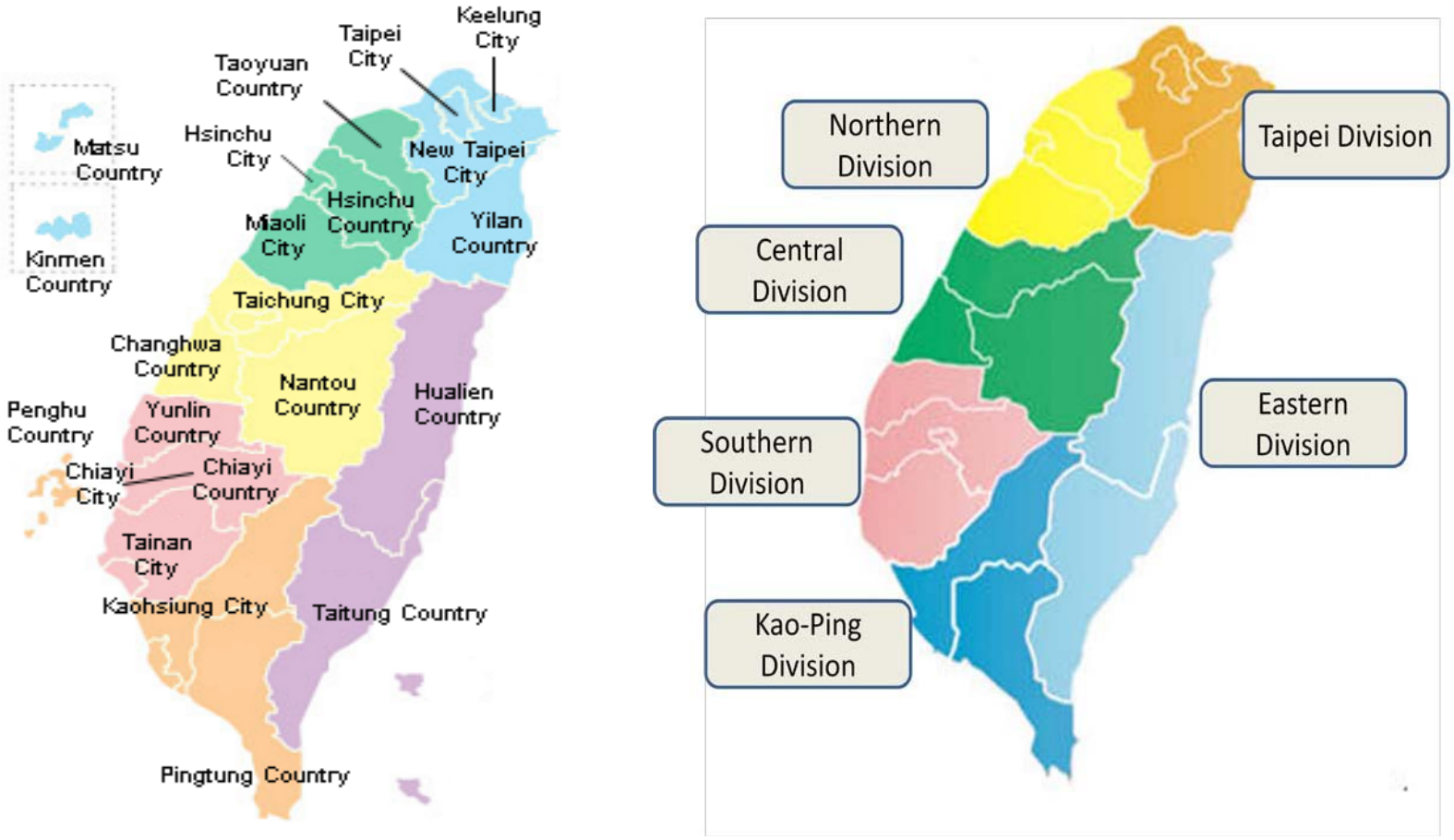
tests or exams, but it did significantly reduce diabetes-related emergency visit(s) and hospitalization(s). Improving provider continuity should be beneficial for diabetes patients. We should understand the causes resulting in low continuity and try to modify the behaviors of the patients and the providers to improve provider continuity. Our study also found the accreditation level of the organization influenced healthcare costs greatly except provider continuity. Diabetes patients cared for at local clinics had better outcomes and lower healthcare costs. Diabetes is a prevalent chronic disease and an ambulatory sensitive condition. Most diabetes-related medical problems could be managed at the local clinic setting. Within the healthcare system characterized by free of physician choice, some people are used to seek health services at hospitals directly. Unrestricted health-seeking behaviors might result in more medical resource consumption and increased healthcare costs. Therefore, health policy makers should seriously consider how to implement a system in which family physicians serve as gatekeepers for referrals to provide effective care for diabetes patients and avoid medical resource overuse.

Appendix 1: International Comparison of Standardized Mortality for Diabetes (based on 2000 WHO world standard population)

Cause of Death	Republic of China (Taiwan) 2013		United States	Germany	United Kingdom	Japan	Australia	Singapore	Republic of Korea
	Crude death rate	Standardized death rate	2007	2012	2010	2011	2011	2011	2011
Diabetes mellitus	40.4	25.8	14.8	10.0	4.4	3.9	9.6	6.1	15.9

Source：Download the detailed data files of the WHO Mortality Database

Appendix 2: Taiwan map and six regional divisions of National Health Insurance Administration (NHIA)



Appendix 3: The distribution of organization ownership by accreditation level

	Accreditation Level of Health Organizations			
Ownership	**Local Clinic**	**Medical Center**	**Regional Hospital**	**District Hospital**
Public	5,716 (25.0%)	6,522 (28.6%)	7,856 (34.4%)	2,749 (12.0%)
Private non-profit	618 (2.1%)	13,942 (47.7%)	10,629 (36.4%)	4,043 (13.8%)
Private profit	18,744 (60.7%)	0 (0.0%)	3,435 (11.1%)	8,726 (28.2%)

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